

## STORMWATER MANAGEMENT ADVISORY REPORT

*An introductory overview of community choices surrounding development impact, hazard mitigation, water quality, and municipal expense associated with storm water management.*



Burlington, VT



[https://upload.wikimedia.org/wikipedia/commons/9/99/StreetSide\\_swaic\\_Sea.jpg](https://upload.wikimedia.org/wikipedia/commons/9/99/StreetSide_swaic_Sea.jpg)

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Montpelier, VT



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Torsken, Senja (Norway)

Town of Milton, Vermont

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## PROJECT BACKGROUND

This report was prepared by Gina Clithero during a summer natural resource planning internship sponsored by the University of Vermont. The purpose of the report is to provide the Town of Milton with information, tools, and recommendations for managing stormwater runoff. The report includes an introduction to Green Stormwater Infrastructure technologies and Low-Impact Development planning principles. Additionally, the report discusses relevant state and municipal policies related to stormwater management, and recommends amendments to town policies to allow for further stormwater treatment in Milton.

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## Table of Contents

<b>EXECUTIVE SUMMARY .....</b>	<b>5</b>
<b>INTRODUCTION .....</b>	<b>8</b>
GROWING ATTENTION TO LAKE CHAMPLAIN .....	9
PROBLEMS RESULTING FROM STORMWATER RUNOFF.....	10
<b>MANAGING AND TREATING STORMWATER .....</b>	<b>13</b>
LOW IMPACT DEVELOPMENT .....	13
“GRAY” INFRASTRUCTURE.....	13
GREEN STORMWATER INFRASTRUCTURE.....	14
IMPORTANT CONCEPTS FOR UNDERSTANDING GREEN STORMWATER INFRASTRUCTURE .....	14
WINTER CLIMATE CONCERNS .....	18
<b>REGULATIONS AND PERMITS.....</b>	<b>20</b>
MUNICIPAL SEPARATE SEWER STORMWATER SYSTEM PERMIT (MS4).....	20
STATE STORMWATER PERMITS .....	21
UNIFIED DEVELOPMENT REGULATIONS AND INFRASTRUCTURE STANDARDS COMMITTEE .....	23
<b>RECOMMENDED TOOLS AND STRATEGIES FOR MILTON’S STORMWATER MANAGEMENT .....</b>	<b>24</b>
1. <i>New Development Mitigation.</i> .....	25
2. <i>Retrofitting of Existing Developments.</i> .....	25
3. <i>Stormwater Master Plan.</i> .....	26
4. <i>Stormwater Advisory Committee.</i> .....	28
5. <i>Stormwater Manager.</i> .....	28
6. <i>Employee Training.</i> .....	29
7. <i>Maintenance Plan.</i> .....	29
8. <i>Public Ownership.</i> .....	30
9. <i>Identify Funding.</i> .....	31
10. <i>Public Demonstration &amp; Leadership.</i> .....	36
11. <i>Engage Regionally.</i> .....	40
12. <i>Public Education and Outreach.</i> .....	40
13. <i>Make it Predictable.</i> .....	41
<b>THE ECONOMICS OF CLEAN WATER .....</b>	<b>43</b>
THE CONSEQUENCES OF INACTION .....	43
<i>Recreation and tourism.</i> .....	43
<i>Property Values and Milton’s Grant List</i> .....	44
<i>Cost of Noncompliance with MS4 Permit.</i> .....	45
<i>Stormwater Impaired Waters</i> .....	45
COST-BENEFIT ANALYSIS OF GSI V.S. GRAY/CONVENTIONAL STORMWATER INFRASTRUCTURE .....	46
<i>Quantifying Multiple Cobenefits</i> .....	46
<i>LID Cost-Effectiveness Case Studies</i> .....	47
<b>CONCLUSION .....</b>	<b>49</b>

<b>REFERENCES .....</b>	<b>50</b>
<b>A1. CCRPC CLEAN WATER FUNDING 2018 .....</b>	<b>53</b>
<b>A3. BURLINGTON EROSION PREVENTION AND SEDIMENT CONTROL FORMS .....</b>	<b>57</b>
<b>A4. CENTER FOR NEIGHBORHOOD TECHNOLOGY: TABLE OF BENEFITS FROM GSI.....</b>	<b>63</b>
<b>A5. COMPARING MAINTENANCE COSTS OF GSI AND GRAY INFRASTRUCTURE .....</b>	<b>64</b>
<b>A6. EPA GUIDE FOR VOLUNTARY LONG-TERM PLANNING .....</b>	<b>72</b>
<b>A7. TOWN OF MILTON 2014 ANNUAL MS4 PERMIT REPORT.....</b>	<b>89</b>



## EXECUTIVE SUMMARY

### The Stormwater Problem

Land development brings the construction of roads, buildings, driveways, and parking lots. Rainwater and snowmelt run across these surfaces because they are impervious. These impervious surfaces disrupt natural water cycles. In pre-developed landscapes, rainwater is captured by trees, evaporates, absorbs into soils, and recharges groundwater supplies. In developed, urbanized landscapes, rainwater pours over impervious surfaces and causes a host of environmental problems.

The urbanization of the Lake Champlain Basin is the most significant threat to the health of Lake Champlain. Lake Champlain's problem contaminant is phosphorus, a nutrient that drives the growth of toxic blue-green algae blooms. Stormwater runoff contributes more phosphorus in an acre-to-acre comparison to the agricultural runoff contribution, which is greater in total. As a result, mitigation measures are required by the U.S. Environmental Protection Agency (EPA) and the VT Agency of Natural Resources (ANR).

Stormwater causes two primary problems for water quality: (1) the contamination of runoff as it picks up pollutants, including phosphorus, while moving across impervious surfaces, and (2) higher volumes of rainwater reaching streams faster. Unmanaged stormwater runoff threatens Milton's drinking water supply, public infrastructure, private properties, grand list, and recreation and tourism industries.

### Managing Stormwater with Green Stormwater Infrastructure and Low Impact Development

Currently, stormwater management in Milton is dominated by conventional "gray infrastructure." Grey infrastructure represents the predominant technologies for capturing and conveying stormwater from impervious surface to nearby surface waters as fast as possible. Gray infrastructure primarily consists of storm drains, pipes, and catch basins. While these systems, when well maintained, perform well for flood reduction, they don't provide adequate stormwater treatment.

Milton must move to more effectively manage stormwater and associated pollutants using Green Stormwater Infrastructure (GSI) practices and Low Impact Development (LID) planning principles. GSI consists of practices that use vegetation and soils to treat stormwater as close to the source as possible. Key principles of GSI are infiltration, evapotranspiration, and storage and reuse. Not only do these practices reduce runoff and treat stormwater, but they can also provide communities with myriad ecosystem services, such as groundwater recharge, carbon sequestration, improved air quality, improved sense of place in communities, reduced electricity and fuel costs, and increased property values.

### Milton and Stormwater: The Urgent Need for a New Approach

According to ANR, a vast majority of impervious surface in Vermont was constructed either prior to the 2002 Stormwater Regulations<sup>1</sup> or exempt from those regulations as a result of their small size (less than one acre). Thus, in order to reduce total phosphorus in Milton's waterways, Milton will need to install stormwater retrofits in existing properties and reduce the added stormwater impact of new development projects. Milton's designation as a Municipal Separate Storm Sewer System (MS4) community places programmatic and reporting requirements on the Town to reduce stormwater runoff, but additional action must be taken to comply with incoming 2018 MS4 requirements.

### Recommendations for Milton

Through the development of this report, recommendations for Milton regarding stormwater management and GSI include:

1. **New Development Mitigation.** Develop process for implementing the erosion and stormwater controls for all new developments in Milton's Unified Development Regulations. Encourage redevelopment to minimize the creation of new impervious surface and preserve important natural features for stormwater management.
2. **Retrofitting of Existing Developments.** Within existing developments, install stormwater retrofits, starting with high impact, cost-effective locations through a Stormwater Master Planning Process
3. **Stormwater Master Plan.** Prepare and implement a town-wide stormwater master planning process with assistance from technical experts.
4. **Stormwater Advisory Committee.** Engage a citizen advisory committee to steward the master planning process.
5. **Stormwater Manager.** A full-time manager can oversee education, development, and maintenance of stormwater retrofits and implementation of LID/GSI
6. **Employee Training.** Train municipal employees to build awareness of stormwater issues, and build knowledge on implementation and maintenance of public GSI projects
7. **Maintenance Plan.** Develop maintenance plan for GSI projects, consider life-cycle costs when weighing options for stormwater infrastructure
8. **Public Ownership.** Consider taking over private stormwater permits and systems to ensure compliance with MS4 permit.
9. **Identify Funding.** Explore innovative funding mechanisms, including a utility fee.
10. **Public Demonstration & Leadership.** Implement GSI public demonstration sites to spread awareness and garner support (public property, high visibility, low cost)
11. **Engage Regionally.** Participate in Green Infrastructure Roundtable and other public awareness groups and projects
12. **Public Education and Outreach.** Develop a pamphlet to send with new permits
13. **Make it Predictable.** Clarify and streamline stormwater site plan review, inspections, and enforcement for all new developments according to Milton's Unified Development Regulations.

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<sup>1</sup> General Permit 3-9015 was initiated in VT in 2002 and requires developments with more than one acre of new impervious surface to follow a set of practices outlined in the 2002 Vermont Stormwater Management Manual (VSMM) rule.

### The Bottom Line

The costs of inaction are significant. The continued degradation of Milton's streams and Lake Champlain will cause more frequent closures of public recreation areas, such as Sand Bar State Park, and the loss of recreation and tourism activities, including fishing and paddling. Property values are already being severely impacted in Georgia and St. Albans by algae blooms in Lake Champlain. Milton has one of the highest percentages of impervious surface of any town along the Lamoille River, which is contributing increasingly significant amounts of phosphorus to the Lake.

Once a town stream is designated as "impaired", or the town is non-compliant with its MS4 Permit, the town will become subject to significant regulatory costs. In addition, unmanaged stormwater poses increased risks of flooding and flood-related damages to public infrastructure and private properties. Moreover, Lake Champlain and Milton's rivers are important assets to the town. GSI and LID are important components of a cost-effective, long-term strategy to protect these assets from the harmful impacts of stormwater runoff.

## INTRODUCTION

Stormwater runoff is principally categorized as water shed by impervious surfaces, such as roofs, pavements, and compacted soils. When it rains in an undeveloped environment, where impervious surfaces are minimal, rainwater is slowed and filtered by natural mechanisms and eventually returned back to groundwater, surface water, and soils. Large volumes of water are slowed by vegetation, and gather in natural vegetated areas. These vegetated areas store water, protect water quality, control erosion, and provide habitat.

In developing landscapes, these natural processes are interrupted through loss of vegetation and the addition of impervious surfaces that cover the soil with a layer of material that water cannot pass through. Impervious surface coverage as low as ten percent can destabilize a stream channel, raise water temperatures, and reduce water quality and biodiversity (Schueler, 1994). Runoff almost doubles when impervious surface area is 10 to 20 percent of the watershed area and triples at 35 to 50 percent (Arnold & Gibbons, 1996 as cited in LTBP, 2016). In other words, as impervious surface increases in a watershed, stormwater runoff increases drastically.

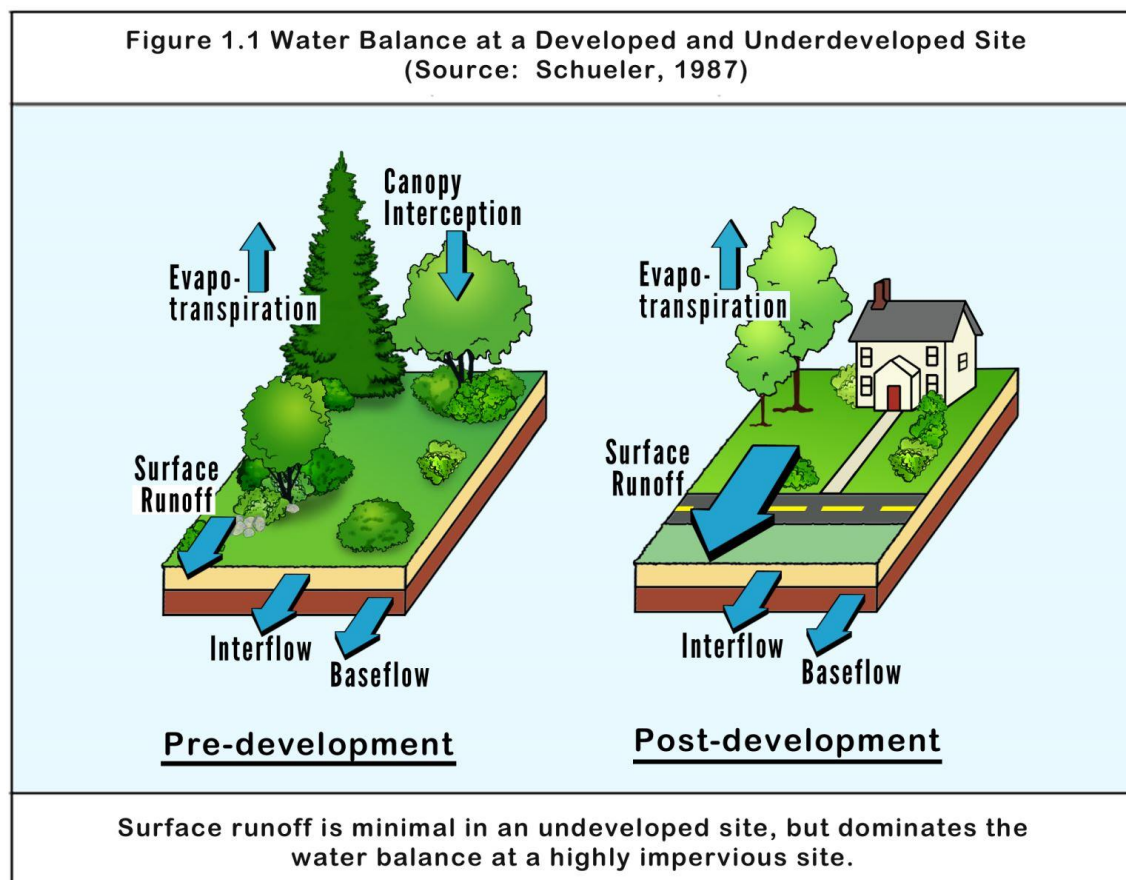


Figure 1. Water cycles in pre- and post-development landscapes (Schueler, 1987).

The runoff generated by impervious surfaces gathers all kinds of contaminants, such as animal feces, trash, oil residues, fertilizers, and other chemical pollutants. As development occurs,

impervious cover increases, altering and stressing the capacity of natural systems to handle unmanaged stormwater. As Milton has grown its economic tax base by building and maintaining industrial parks, large commercial properties in the Town Core, transportation infrastructure, and housing developments, Milton's impervious surface has grown rapidly.

## Growing Attention to Lake Champlain

As a larger Vermont community, Milton's impervious surfaces contribute to the Lake's phosphorus load, and as a growing community served by development-supporting infrastructure and zoning, Milton has the capacity to positively or negatively affect the water quality of Lake Champlain. Milton is part of several watersheds, all of which flow to Lake Champlain via streams and rivers.

Over the past several decades, there has been an increasing public awareness of water quality in Lake Champlain, principally resulting from increased incidents of toxic, blue-green algae blooms. These algae blooms form as a result of excessive nutrients in standing water. The principal cause of this water quality crisis in Lake Champlain is phosphorus.

Phosphorus is the limiting nutrient for blue-green algae. Thus, in its absence, algae will not grow. However, when there is excessive phosphorus in the water, blue-green algae will thrive. Stormwater has been found to be a major contributing factor to Lake Champlain's (the Lake) phosphorus load (State of the Lake, 2015). While some amount of phosphorus is important for aquatic life in Lake, there is a limit to the amount it can process. The Environmental Protection Agency (EPA) mandates that states determine a target for reducing the Lake's phosphorus load. They do so by requiring states to establish Total Maximum Daily Load (TMDL) that enumerates a target for reducing nutrients to a level that the ecosystem can manage.

Phosphorus in the Lake comes primarily from nonpoint sources. While point source pollution can be traced to a particular facility or pipe directing contaminants into water, nonpoint pollution is caused primarily by runoff. Identifying and addressing properties that contribute to nonpoint source pollution is complex. Nonpoint source pollution of phosphorus into the Lake is caused by rainfall and snowmelt pouring across agricultural lands and developed lands, such as roads, buildings, and lawns; it is then conveyed through storm drains and piping systems into nearby surface waters.

According to the 2015 *State of the Lake* report by the Lake Champlain Basin Program, on average, urban stormwater runoff accounts for 16% of phosphorus loading into the Lake, while agriculture contributes 38% of the total phosphorus load. This ratio varies for different segments of the lake. In Mallets Bay in Colchester, about 40% of the phosphorus loading is caused by stormwater runoff across developed landscapes, including developed areas in Milton. While agriculture contributes more phosphorus to the Lake in total, phosphorus in runoff from developed landscapes contributes more phosphorus on an acre-to-acre basis. According to the Lake Champlain Basin Program, each acre of developed land sends three times the amount of phosphorus to the Lake than an acre of agricultural land. The EPA estimates that while only 5% of the land cover in the Lake Champlain Basin is impervious surface, urban runoff contributes 13.5% of the phosphorus

pollution to the Lake (Moore, 2016). Because the contribution of developed lands is more concentrated, it is more cost effective to target phosphorus loading from developed lands than agricultural lands.

A majority of Milton is part of the Lamoille River watershed, and Milton is one of the top phosphorus polluting towns to the Lamoille River, contributing a total phosphorus load of 572 kilograms per year (Lamoille Tactical Basin Plan, 2016). Phosphorus loading from the Lamoille River has increased in the past 20 years, more so than any other Lake Champlain tributary in Vermont (State of the Lake, 2015). Milton's efforts to reduce stormwater runoff will improve the water quality of Lake Champlain.

## Problems Resulting from Stormwater Runoff

Stormwater runoff causes two primary problems for water quality: (1) the contamination of runoff as it picks up pollutants while moving across impervious surfaces, and (2) higher volumes of rainwater reaching streams faster which leads to channel erosion, increased sediment transport, and degraded water quality.

### *Elevated nutrient and contaminant levels*

When rain falls in a forest, water is intercepted by leaves, slowed by roots and vegetation, and absorbed into the soil. When rain falls on an impervious surface, such as a residential neighborhood or a commercial parking lot, it pours across the surface, gathering contaminants, such as oil, grease, trash, soil sediment, and metals, and into a storm drain or ditch, destined for the nearest stream, river, or lake. The contaminants in stormwater are most concentrated in the first inch of rainfall, thus even a small rain event can have detrimental impacts on surface water quality.

Snowmelt is also an important component of stormwater runoff. During winter, de-icing practices on Vermont roads result in high concentrations of salt in snow banks. Road salt significantly impacts water quality in Vermont, and is an important component of Vermont's stormwater pollution problem. A recent study demonstrated that only 1% impervious cover in the area surrounding a lake increases the likelihood of long-term salinization (Dugan et al., 2017). The salinization of Vermont's water bodies impacts aquatic wildlife and threatens drinking water sources. In 2013, the UVM Spatial Analysis lab estimated that between 4-16% impervious surface cover in the Mallets Bay area, and 16-33% impervious surface in the Burlington area (O'neil-Dunne, 2013). The salinization of large fresh water lakes is not a problem isolated to Vermont; 27% of large lakes in the U.S. have above 1% impervious surface cover in the surrounding lake shore area (Dugan et al., 2017).

According to the Lake Champlain Basin Program, approximately 145,000 people, or about 20% of the Basin population, depend on Lake Champlain for drinking water. Approximately 4,149 draw water directly from Lake Champlain for individual use. There are 99 public water systems drawing water from Lake Champlain, including the Champlain Water District that serves Milton and 9 other public water systems (State of the Lake, 2015).

### *Increased volume of rainwater reaching streams*

When an inch of rain falls on an acre of forest, typically 2,000 gallons of water will run off the land and not be absorbed<sup>2</sup>. When an inch of rain falls on an acre of impervious surface, 25,000 gallons of water are typically sent directly to a nearby river (Moore, 2016). Like all natural systems, rivers and streams have a natural capacity. When the volume of water exceeds that capacity, the waterways destabilize. Runoff entering rivers at higher volumes, speed, and force can result in expensive public infrastructure consequences.

When rivers move faster and waters are higher in storm events, river and stream banks are more likely to erode, which is the process of river banks falling into the river. Erosion results in water containing suspended sediments, which increases the flood damage potential of stormwater. In order to reduce flood risks, Milton must reduce the volume of stormwater entering rivers, protect vegetated riparian buffers to stabilize banks, and continue prioritizing the protection of wetlands.

Rivers change over time as land use, valley slopes, and sediment loading change. This long term process is called *channel evolution*. All rivers are at some stage in the channel evolution process depicted in Figure 2. According to Mike Klein of ANR, increased impervious surface and ditching for economic development have increased the rate and volume of water relative to sediment runoff, resulting in increased channel incision and widening.

When rivers incise, they will inevitably transition to the next stage in channel evolution, which is widening. Widening rivers pose significant risks to public infrastructure, such as roads, bridges, and culverts. Private infrastructure is also threatened by increased flood risks, especially property in flood hazard areas. Of 1,500 river miles in Vermont assessed by ANR, 75% were found to be at an unstable stage in channel evolution (incising, widening, or stabilizing), thus only 25% were stable (Rivers and Roads, 2017). Stormwater runoff alters flows and keeps rivers from becoming stable.

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<sup>2</sup> This number may vary when the ground is frozen during winter and early spring.



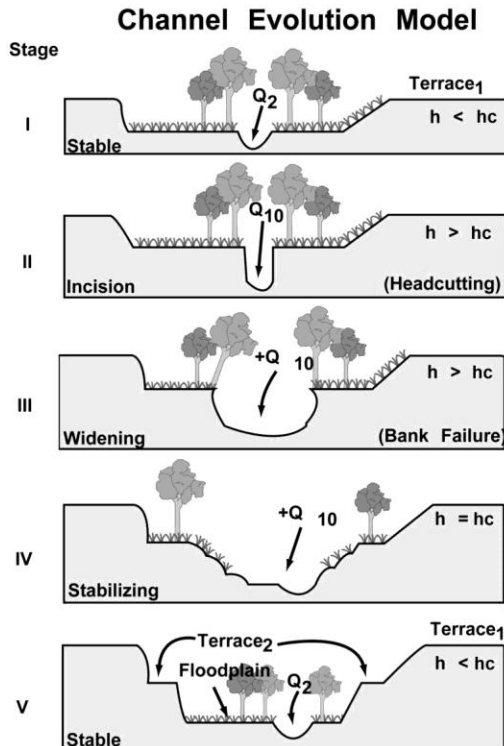


Figure 2. Channel evolution model represents an ongoing process that rivers undergo as a result of land use patterns, valleys and slopes, and sediment, among other factors. Photo source: [http://riverrestoration.wikispaces.com/desert\\_rivers](http://riverrestoration.wikispaces.com/desert_rivers)

Unhealthy stream flow regimes contribute to increased flood risk, as well as degraded aquatic habitat, and water quality. The increased suspended sediments in rivers from bank erosion also undermine water quality, because phosphorus binds with sediment (Kline, 2015). Further, impervious surfaces are warmed by the sun, subsequently warming surface runoff. When a large amount of warm surface runoff reaches streams, it can cause the river temperatures to increase. Higher river temperatures, higher nutrient and contaminant levels, and higher suspended sediments all result in degraded aquatic and wildlife habitat and therefore reduced species diversity (Vermont Green Infrastructure Initiative, n.d.).

## MANAGING AND TREATING STORMWATER

### Low Impact Development

The ultimate goal for stormwater management is to reduce the impact of urbanization on our waterways. Low Impact Development (LID) planning principles recognize the many benefits ecosystem functions provide human societies, from cleaner water and air to improved health and social indicators, and encourage land uses that support valuable ecological functions. LID seeks to “maintain a site’s pre-development ecological and hydrological function through the protection, enhancement, or mimicry of natural processes” (Vermont Green Infrastructure Initiative, n.d.). On the ground, LID planning is central to the design of conservation subdivisions, smart growth areas, urban forestry, and green streets.

Principles of Low Impact Development (LID) include:

- Mimic pre-development hydrology;
- Balance ecological preservation and conservation with economic growth and development;
- Build systems that are sustainable and maintainable;
- Decentralize drainage infrastructure by maximizing onsite storage filtration and infiltration;
- Make use of natural landscape features to best manage runoff; and
- Deal with stormwater as a valuable natural resource (Moore, 2016, Roseen et. Al., 2011).

These principles help foster built environments that work in harmony with the natural environments that we depend upon. LID principles promote a patchwork of decentralized stormwater treatment and control practices. In the next section, this report discusses the particular practices and technologies for managing and treating stormwater on-site.

### "Gray" Infrastructure

The predominant tools for capturing and managing stormwater include storm drains, pipes, and catch basins. Some call these tools “conventional” stormwater management practices, while others refer to them as “gray infrastructure”. In general, conventional or gray stormwater infrastructure collects and moves stormwater runoff as quickly as possible from impervious surfaces to centralized locations for treatment or discharge into surface waters (Roseen, Janeski, Houle, Simpson, & Gunderson, 2011).

Conventional stormwater infrastructure was originally designed for flood reduction in developed areas—and when systems are well-maintained, it works really well for that (Becky Tharp of the VT Green Infrastructure Collaborative, personal communication, August 5, 2017). As the infrastructure expanded and we began to see the water quality concerns with discharging large volumes of water into natural waterways, stormwater ponds were popularized as a way to store large

volumes of water during a rain event. Stormwater ponds (a.k.a. wet ponds or retention ponds) slowly release the water to receiving waters to address the discharge volume problem. Some nutrients and suspended sediments are removed from the water by settling in these ponds, but they do not significantly remove dissolved phosphorus, the problem nutrient for Lake Champlain (J. J. Houle et al., 2013a; Schwartz, Sample, & Grizzard, 2017).

Conventional gray stormwater infrastructure collects stormwater in a centralized location, provides little to no water quality treatment, and discharges stormwater to nearby surface waters. While conventional stormwater reduces flood risks in one urbanized area, it poses flood risks and associated water quality challenges for downstream communities.

## Green Stormwater Infrastructure

GSI is a new way of looking at stormwater management, where volume is managed in lots of little systems that mimic natural systems that infiltrate and filter. GSI uses vegetation and soils to restore natural processes required to manage and treat stormwater. GSI systems remove phosphorus, nitrogen, and suspended sediments more effectively than conventional gray infrastructure (J. J. Houle et al., 2013). The Vermont Department of Environmental Conservation (DEC) defines GSI as “systems and practices that restore and maintain natural hydrologic processes in order to reduce the volume and water quality impacts of the built environment while providing multiple societal benefits.” In addition to stormwater management and treatment, a variety of GSI practices provide community benefits, such as air quality improvements, groundwater recharge, and increased property values. For more on community benefits, see *Quantifying Multiple Cobenefits*.

GSI technologies are based on three principles: infiltration, evapotranspiration, and storage, which are all natural hydrological functions.

## Important Concepts for Understanding Green Stormwater Infrastructure

### Infiltration

Infiltration is the process of water sinking into the soil. As water moves through the soil, it is filtered by particles attached to plant root systems, helping remove sediment, toxins, and contaminants from runoff. Infiltration also recharges groundwater supplies and reduces flood risk by delaying the conveyance of stormwater into nearby waterways. Examples of GSI infiltration practices are infiltration trenches, bioretention facilities, and porous pavement. Infiltration practices are most applicable on well-drained soils without a perched (close to the surface) water table.

Sandy soils – such as those predominantly found in Milton - are typically well-drained, leading them to work best for infiltration practices, because the large soil particles leave larger spaces between each particle for water to pass through. The more water that can move through the soil at a time, the faster that stormwater can be absorbed into the ground and treated by its movement through soil and root systems.

Water table depth is the other key factor for determining the feasibility of infiltration practices. With a high water table, groundwater can be at increased risk for contamination associated with infiltration of contaminated stormwater. Without sufficient space between the ground surface

and the ground water table, stormwater will not be properly treated. Some areas for planned growth in Milton have sandy soil and a high water table, such as the Checkerberry area. Designers and stormwater engineers will determine evaluate the challenges and opportunities for on-site infiltration practices to mitigate runoff from new development in the Checkerberry Area.

According to the 2007 *Vermont Stormwater Management Manual* and the Vermont Green Infrastructure Collaborative, infiltration is the most cost-effective and efficient practice for stormwater treatment where the conditions are favorable (VSMM, VTDEC).

*See examples below<sup>3</sup>.*



#### Porous Pavement

Porous pavement (a term that includes pervious concrete, porous asphalt, permeable paver blocks and reinforced turf) is an infiltration BMP that combines storm-water infiltration, storage, and structural pavement consisting of a permeable surface underlain by a storage or infiltration reservoir. Pervious pavement is well suited for parking lots and paths. (Photo taken at UVM in Burlington, VT)



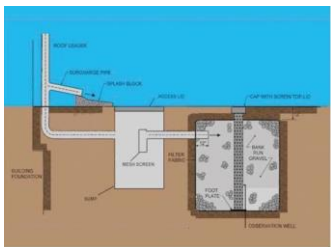
#### Infiltration Trench

Infiltration trenches are shallow open channels lined with dense vegetation. The first flush from a storm event can be diverted to infiltration trenches. They are highly versatile and can be applied in small residential areas to extensive systems to address downtown, commercial, and industrial impervious surfaces such as a parking lots, roads/sidewalks and rooftops.



#### Bioretention and Rain Gardens

Bioretention facilities and rain gardens reduce stormwater volume and pollutant load, while providing aesthetic value. These facilities take form in landscaped depressions that are filled with sand, native soil, compost, and are planted with trees, shrubs, and other native vegetation. Smaller systems are typically called rain gardens and larger systems called bioretention facilities. (Photo taken at 133 State Street, Montpelier, VT)



Source: PA Stormwater Best Management Practices Manual

#### Dry Well

A dry well is a subsurface storage facility that temporarily stores and infiltrates stormwater runoff from the roofs of residential and small structures. Roof leaders connect directly into the dry well, which may be either an excavated pit filled with uniformly graded stone, wrapped in geotextile or a pre-fabricated storage chamber or pipe segment.



#### Vegetated Swale (Bioswale)

Vegetated swales function in similar nature to rain gardens with shallower bioretention depth, and a linear orientation. Vegetated swales are packed with plants and bushes, and function well for landscaping elements in residential and commercial lawns, commercial parking lots, and in along driveways and streets. (Photo taken at CCV in Montpelier, VT)

<sup>3</sup> GSI descriptions and photos are adapted from the GSI Concepts Factsheet by the Vermont Green Infrastructure Initiative of the Vermont DEC. For more information: [https://anrweb.vt.gov/PubDocs/DEC/WSMD/stormwater/docs/sw\\_gi\\_2.0\\_GSI\\_series.pdf](https://anrweb.vt.gov/PubDocs/DEC/WSMD/stormwater/docs/sw_gi_2.0_GSI_series.pdf)

## Evapotranspiration

Evapotranspiration is a crucial part of the hydrological cycle, where water is evaporated back into the atmosphere through plant leaves. Evapotranspiration releases water into the atmosphere as a push and pull process for the uptake of a mix of water and nutrient solution in the soil. When water evaporates out of the pores of a tree's leaves, it maintains a pressure gradient that encourages more water in the soil to move up through the tree's vascular system in its trunk. Trees serve a critical role of taking water out of the soil and returning it to the atmosphere. This is an important function for stormwater management because stormwater deposited near a tree's roots will return to the atmosphere. It is important to understand that the larger the tree, the more capacity it has to move water from the soil through evapotranspiration; hence, large, healthy, mature trees provide significantly enhanced stormwater benefits.

Additionally, trees provide many other aesthetic, environmental, and economic benefits to a community. The installation, maintenance, and retention of urban trees are important components for efficient stormwater management.

*See examples below<sup>4</sup>.*



### Green Roof

A green roof is the roof of a building that is partially or completely covered with vegetation. Green roofs serve many purposes, one of which is stormwater management. They are capable of absorbing, storing, and evapotranspiring a great deal of water. In cold climates, architectural/engineering consultation is extremely important due to the additional weight of snow and ice.



### Constructed Wetland

A constructed wetland is a shallow retention pond designed to permit the growth of wetland plants such as rushes, willows, and cattails. Constructed wetlands slow runoff and allow time for sedimentation, filtering, and biological uptake. Constructed wetlands are designed specifically to mimic natural wetland environments. They are heavily vegetated and thus have high evapotranspiration rates. (Photo taken in St. Albans)



### Stormwater Tree Pit

Stormwater tree pit systems use engineered soils to infiltrate and filter stormwater. They are particularly useful in tight urban and downtown locations. Some systems allow for increased soil volume to grow large mature trees resulting in increased E<sub>T</sub> and other benefits. Most of these systems are able to promote vigorous root growth beneath existing infrastructure such as roads and sidewalks with little to no conflict. (Photo taken in Burlington, VT)

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<sup>4</sup> GSI descriptions and photos are adapted from the GSI Concepts Factsheet by the Vermont Green Infrastructure Initiative of the Vermont DEC. For more information: [https://anrweb.vt.gov/PubDocs/DEC/WSMD/stormwater/docs/sw\\_gi\\_2.o\\_GSI\\_series.pdf](https://anrweb.vt.gov/PubDocs/DEC/WSMD/stormwater/docs/sw_gi_2.o_GSI_series.pdf)

## Storage and reuse

Storing and reusing water is a key stormwater management technique. Water running off of roofs can be stored in rain barrels and used at a later time for gardening or other gray water uses. Storage and reuse practices primarily address the issue of water volume, which mitigates flash flooding risks, channel instability, and nutrient loading. Additionally, these practices capture runoff from the first inch of rainfall, which is termed the “first flush” because it has the highest concentration of pollutants.

*See examples below<sup>5</sup>.*



### Rain Barrel/Cistern

Rain barrels/cisterns are designed to intercept and store runoff from rooftops. The stored volume can then be used for a variety of things. Rain barrels are typically 55 gallons in size and are perfect for small residential sites. Cisterns can be 100 gallons or more and are appropriate when greater storage is needed. 1,000 square feet of impervious generates 623 gallons of water in a 1” storm.



### Underground Storage

Underground storage can be used to capture and store rainwater from surrounding impervious surfaces such as a building roof or parking lot. Often, riser pipes and curb cuts lead runoff to subsurface vaults and large diameter pipes. Stored water is often used for irrigation. Underground storage can be placed beneath a parking lot or recreation field.



### Rainwater Reuse

Rainwater reuse systems often involve the storage and reuse of water collected from roof surfaces during rain events. These systems are somewhat similar to rain barrels and cisterns but done on a much larger scale and include pumps and sometimes complex filtering systems. Potential uses include water for flushing toilets and irrigation.

## Structural versus Non-Structural Practices

The Vermont Stormwater Management Manual differentiates between two types of stormwater treatment: structural and non-structural practices. Structural practices involve some degree of earth disturbance to install, while non-structural practices are maintenance and prevention practices, such as street sweeping and catch basin cleaning.

Both types of practices are important, and both should be integrated into a stormwater plan for Milton. Although some studies point to the effectiveness of only structural practices, non-structural practices can be just as effective-if not more effective-than structural practices at reducing sediment pollution to waterways. For example, see the graph below from South Burlington that demonstrates long-term monitoring of the total suspended sediment (TSS) in a waterway.

<sup>5</sup> GSI photos and technologies are adapted from the GSI Concepts Factsheet by the Vermont Green Infrastructure Initiative of the Vermont DEC. For more information: [https://anrweb.vt.gov/PubDocs/DEC/WSMD/stormwater/docs/sw\\_gi\\_2.0\\_GSI\\_series.pdf](https://anrweb.vt.gov/PubDocs/DEC/WSMD/stormwater/docs/sw_gi_2.0_GSI_series.pdf)



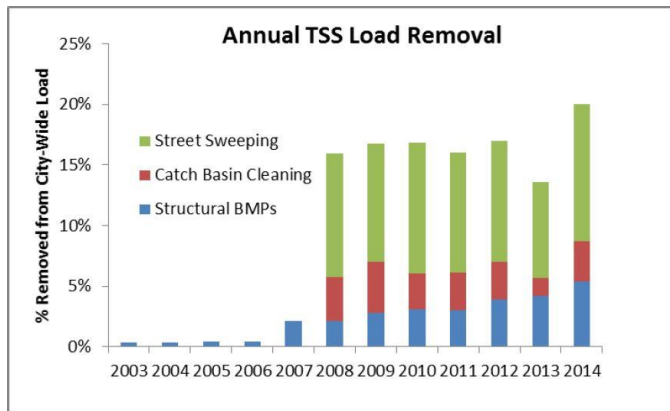


Figure 4. South Burlington's tracking of Total Suspended Solids removal. Source: Powerpoint shared by Tom Dipietro, Stormwater Superintendent for the City of South Burlington.

### Combining GSI with Gray Infrastructure

There are a variety of GSI practices in use in Vermont today, including rain gardens, green roofs, and permeable pavement. Conventional stormwater drainage and piping systems can work in concert with GSI to result in protection of built infrastructure and better water quality outcomes.

## Winter Climate Concerns

### Freezing

Freezing is a concern for all types of infrastructure in northern climates. University of New Hampshire (UNH) researches have determined that there is no loss of performance as a result of freezing temps in infiltration and filtration practices (Roseen et al., 2009; Roseen, Ballesterio, Houle, Briggs, & Houle, 2012a). For example, bioretention systems, urban trees, subsurface gravel wetlands, and other LID systems maintained high levels of performance year-round. Meanwhile, more conventional systems, such as bioswales and hydrodynamic separators became significantly less effective in the winter months. Permeable paver systems did not suffer any performance reduction as a result of freeze-thaw temperature cycles (K. M. Houle, 2008). Rather, permeable pavement showed no adverse freeze-thaw effects, such as heaving, over a 6 year UNH Stormwater Center study, indicating that the the life span is expected to exceed that of typical pavement applications in northern climates (Roseen, Ballesterio, Houle, Briggs, & Houle, 2012).

### Ice/Snow

A fundamental problem with GSI installation in Vermont is damage from snow storage. Vegetated areas adjacent to impervious surfaces, such as right-of-ways, medians, or parking lot islands, serve as ideal locations for GSI technologies. Unfortunately, these areas tend to gather large snow banks deposited from snow plows. Snow storage in bioretention facilities or urban tree boxes can compact the soil and cause damage to these facilities.



## Salt

Salt significantly damages the winter performance of pervious concrete (Suozzo & Dewoolkar, 2012). Due to the large amount of salt applied to Vermont roads and parking lots, Vermont hasn't invested significantly in pervious concrete. A 2012 study with UVM and the Vermont Transportation board found that the maintenance demands were very high for pervious concrete, because salt clogged the material. A 2016 study with UVM and VTrans found that porous concrete had improved winter performance when it was mixed with aggregate (5% sand, slag (steel by-product), or silica flume (by-product of silicon smelting)).

Porous asphalt, on the other hand, is less sensitive to salt. With frequent salt applications, porous asphalt maintained high infiltration capacity (Roseen et al., 2012a). While porous asphalt maintains its functionality under traditional salting conditions, porous asphalt reduces the need for salt deicing by 75% due to water infiltration and increased skid resistance (K. M. Houle, 2008). This significant salt reduction could help Vermont address the long-term salinization of Lake Champlain by road salt. Additionally, the salt application reduction lowers maintenance costs, contributing to the lower life cycle costs of porous asphalt in comparison to impervious pavement. According to the DEC, porous asphalt is the least expensive permeable paver material.

## REGULATIONS AND PERMITS

### Municipal Separate Sewer Stormwater System Permit (MS4)

MS4 stands for Municipal Separate Sewer Stormwater Systems, and is a state permit designated for urban areas, since population density can be used as an indicator of impervious surface (Arnold & Gibbons, 1996). The MS4 permit is a central component of the National Pollutant Discharge Elimination System, an Environmental Protection Agency (EPA) regulation authorized by the Clean Water Act of 1972. The MS4 Permit is designed by the EPA, and administered by states. A section of Milton (pictured below) is automatically designated as an MS4 community based on the 2000 Census-defined Urbanized Area.

Milton is one of fifteen MS4 permit-holders in Vermont. Other municipalities include Burlington, Colchester, Essex, Essex Junction, Shelburne, South Burlington, Williston, Winooski, City of St. Albans, Town of St. Albans, and Rutland. Non-traditional MS4 permit-holders are the Vermont Agency of Transportation, the University of Vermont, and the Burlington International Airport, whose designation results from the significant impervious surface impact of these institutions. At this time, only a fraction of Milton's entire town area is included in the MS4 permit area. Sections of Middle Road, Railroad Street, and the Poor Farm Area are included in the MS4 district. The MS4 permitted area is likely about ten percent the total town area. See MS4 map below, and see Appendix 7 for Milton's 2014 MS4 Permit Report.

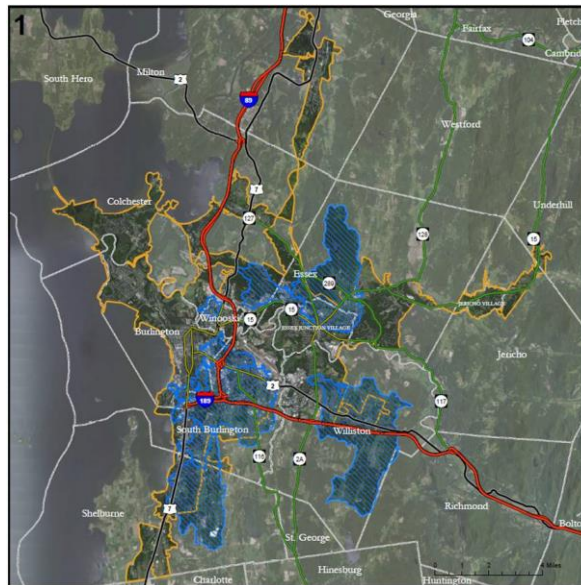


Figure 8. Map of MS4 Permitted areas in Greater Burlington Area. Source: Ben Heath, July 10<sup>th</sup> Milton Selectboard Meeting Presentation Slides.

Ben Heath, consultant from Hamlin Consulting Engineers, has been coordinating with the Planning Director, the Town Manager, the Public Works Supervisor, and various other stakeholders to gather documentation for Milton's MS4 annual report. Ben Heath is currently aggregating information to help Milton demonstrate compliance with the MS4 permit, and prepare Milton's

decision-makers for stricter MS4 requirements in the near future. Ben Heath presented at a Selectboard meeting on July 10<sup>th</sup>, 2017 to discuss MS4 permit requirements. In the meeting, he outlined the various steps Milton must take to be in compliance with MS4 requirements, many of which are discussed in the *Recommendations* section pages 24-42. Ben also revealed new requirements that will likely emerge in 2018.

#### New MS4 Requirements for 2018 Permit

In order to comply with future MS4 permit requirements, there are additional steps Milton must take to mitigate stormwater impacts on the Lake. At the aforementioned Selectboard meeting, Ben Heath presented the likely changes MS4 permit-holders will see to the 2018 MS4 Permit. The additional requirements are:

1. The MS4 Permitted Area will be expanded to the Town boundary (currently only a sliver near town core area), approximately quadrupling (or more) the size of the MS4.
2. Milton will be required to remove phosphorus and track removal from watersheds.
3. Milton will be required to develop a phosphorus reduction plan to meet the aforementioned removal targets over a designated period of time.

#### *1) Expanded MS4 Permitted Area*

The increase in area under an MS4 permit prompts conversations about towns taking over private stormwater systems—conversations that have been less urgent in Milton with only a small MS4 permitted area. Milton currently has a large number of stormwater systems under private ownership. This complicates the process of monitoring and maintenance to ensure compliance with the MS4. For more information, see *Public Ownership* on page 31.

#### *2) Requirement to Remove Phosphorus and Track Removal*

MS4 communities will be provided with a total phosphorus (TP) load requirement, and they will be required to track removal using an online reporting tool provided by the State. In order to reduce total phosphorus, Milton will need to install stormwater retrofits in existing properties, while taking rigorous action to reduce the added stormwater impact of new development projects.

#### *3) Development of a Phosphorus Reduction Plan*

The incoming permit requirements mandate a plan for reduction in the TP in Milton's waterways. Although it isn't clear at this time exactly what the required TP levels will be for Milton and how they will be implemented, there are clear next steps that Milton can take to prepare for this new requirement. An important tool for planning phosphorus reduction is Stormwater Master Planning. To read more, see *Stormwater Master Plan* on page 26.

### **State Stormwater Permits**

Since the introduction of the Vermont Stormwater Management Manual (VSMM) and General Permit 9015 in 2002, 1 acre or greater of disturbed earth or 1 acre or greater of newly

created impervious surface mandates authorization to discharge stormwater from the Vermont ANR. The permits involved with this process are based on the VSMM, which guarantees that stormwater treatment and management is completed according to robust standards (Moore, 2016). ANR is aware that a significant number of projects fall beneath the 1 acre impervious surface threshold, thus they do not trigger state regulations for post-construction stormwater management. ANR has recently been encouraging the Vermont legislature to reduce the permitting threshold to half-an-acre of impervious surface (ANR, 2016 as cited in Moore, 2016). ANR estimates that this change would result in a doubling of the number of post-construction stormwater permits issued annually, requiring treatment for an additional 100 acres of new construction each year (Moore, 2016).

The state permit thresholds have yet to decrease, meaning municipalities have the responsibility to mitigate the stormwater runoff impacts of these sub-jurisdictional properties (Moore, 2016). A majority of existing impervious surface in Vermont was developed prior to 2002, when the post-construction stormwater management requirements went into effect (ANR, 2016 as cited in Moore, 2016). As a state with a significant amount of aging infrastructure, and with most development creating less than an acre of impervious surface, By some estimates, as much as 90 percent of existing impervious cover is not governed by a stormwater permit (Moore, 2016). In order to meet the Lake Champlain TMDL, these existing untreated or inadequately treated surfaces will require GSI retrofits. Municipalities have the primary responsibility to facilitate the implementation of GSI retrofits in MS4 permitted areas.

Milton has taken initiative to address some of the sub-jurisdictional properties within the town. In the Draft Unified Development Regulations, Milton requires that sites creating 10,000 ft<sup>2</sup> of new impervious surface must meet the Vermont Stormwater Management Manual, which is almost ¼ of an acre. The development of 5000 ft<sup>2</sup> of impervious surface requires designers use the GSI Sizing Tool, which is a Vermont DEC tool for designing GSI for small development projects. In the next several months, the Infrastructure Standards Committee will integrate GSI and LID principles into Milton's transportation infrastructure standards. See more information about this project in the next section of the report.

However, lowering permitting thresholds alone will not protect Vermont's waterways from stormwater pollution. While state permitted developments typically generate less stormwater runoff than unregulated stormwater management systems, any creation of impervious surface decreases water quality. Vermont state permits don't require stormwater runoff to be completely managed and treated on-site, thus permits provide developers the ability to pollute surface waters. Although state permitted developments are estimated to prevent sediment runoff (80-90% prevented), only 40-60% of phosphorus runoff is prevented from leaving the permitted site (Moore, 2016). Consequently, each state permitted development project contributes approximately .9 pounds more phosphorus per acre each year than a typical forest or an undeveloped natural area (New Hampshire Department of Environmental Services, 2008 as cited in Moore, 2016).

In order to reduce stormwater pollution, the creation of new impervious surfaces must be limited. Municipalities have the authority to limit the creation of new impervious surfaces by shaping

new or re-development specifications and bylaws and guiding developers towards existing impervious surfaces, such as abandoned buildings and oversized parking lots.

While state and town policies can reduce the stormwater impact of new development projects, this will only tackle a small fraction of stormwater runoff in Vermont's lakes and rivers. A majority of existing impervious surfaces in Vermont were developed prior to current stormwater permit standards were in effect (Moore, 2016). In order to significantly reduce stormwater runoff in Vermont, stormwater retrofits must be installed in order to capture and treat runoff from polluting properties that were either developed prior to stormwater permitting in 2002, or were too small to trigger municipal or state stormwater regulations. Stormwater retrofits are projects where GSI structural practices can be installed and utilized to manage and treat stormwater.

### Unified Development Regulations and Infrastructure Standards Committee

In July 2017, the Infrastructure Standards Committee (ISC) began working with a consultant to address inconsistencies among Milton's land development ordinances, such as: the Public Works Specifications, the Zoning Regulations, and the Subdivision Regulations -- and with the Town Plan - by establishing coordinated, clear, and context-specific standards for private and public transportation infrastructure to ensure that new infrastructure:

- Is economically scaled and built according to its use and context;
- Calms traffic by aligning design with intended speed limits and modes;
- Expands transportation choice;
- Protects water quality; and
- Mitigates stormwater permitting and permit compliance costs.

In addition, the ISC was offered free technical support through a US Forest Service-funded initiative called the Resilient Right-of-Ways Project. The project team includes staff from the Vermont Urban & Community Forestry Program, the Vermont League of Cities and Towns, the University of Vermont, and the State of Vermont's Green Infrastructure Collaborative. The group is providing technical expertise to Milton and nine other urbanized municipalities statewide in increasing municipal capacity to support GSI in public right-of-ways to reduce the stormwater impacts of new developments. Services offered by this group include bylaw review and revision recommendations, development of photo visualizations of GSI practices, and GSI training for Public Works employees and Development Review Board members.

## RECOMMENDED TOOLS AND STRATEGIES FOR MILTON'S STORMWATER MANAGEMENT

This section includes recommendations for Milton to address the stormwater runoff. Milton is currently juggling multiple stormwater-related projects. These recommendations outline methods that Milton can continue pursuing compliance with the MS4 requirements, while preparing for additional MS4 permitting requirements in 2018. In the following section, I provide several actions that Milton can take to build a comprehensive stormwater program. Where recommended actions would help fulfill minimum control measures for Milton's current MS4 permit, the minimum control measures are enumerated.

1. **New Development Mitigation.** Develop process for implementing the erosion and stormwater controls for all new developments in Milton's Unified Development Regulations. Encourage redevelopment to minimize the creation of new impervious surface and preserve important natural features for stormwater management.
2. **Retrofitting of Existing Developments.** Within existing developments, install stormwater retrofits, starting with high impact, cost-effective locations through a Stormwater Master Planning Process
3. **Stormwater Master Plan.** Prepare and implement a town-wide stormwater master planning process with assistance from technical experts.
4. **Stormwater Advisory Committee.** Engage a citizen advisory committee to steward the master planning process.
5. **Stormwater Manager.** A full-time manager can oversee education, development, and maintenance of stormwater retrofits and implementation of LID/GSI
6. **Employee Training.** Train municipal employees to build awareness of stormwater issues, and build knowledge on implementation and maintenance of public GSI projects
7. **Maintenance Plan.** Develop maintenance plan for GSI projects, consider life-cycle costs when weighing options for stormwater infrastructure
8. **Public Ownership.** Consider taking over private stormwater permits and systems to ensure compliance with MS4 permit.
9. **Identify Funding.** Explore innovative funding mechanisms, including a utility fee.
10. **Public Demonstration & Leadership.** Implement GSI public demonstration sites to spread awareness and garner support (public property, high visibility, low cost)
11. **Engage Regionally.** Participate in Green Infrastructure Roundtable and other public awareness groups and projects
12. **Public Education and Outreach.** Develop a pamphlet to send with new permits
13. **Make it Predictable.** Clarify and streamline stormwater site plan review, inspections, and enforcement for all new developments according to Milton's Unified Development Regulations.

## 1. New Development Mitigation.

Encourage redevelopment to minimize the creation of new impervious surface and preserve important natural features for stormwater management.

New development mitigation at the town scale (long-term)

- Integrating LID principles into Town Plan and UDR.
  - Encourage town core development and incentivize redevelopment to minimize impervious surface growth. The Vermont Agency for Commerce and Community Development offers financial incentives to communities and developers for building mixed-income housing within or adjacent to designated Town Core areas through the Neighborhood Development Areas program. Milton should promote these opportunities to developers to promote infill development. Reducing impervious surface cover also can help Milton fit Vermont's historic development pattern of clustered villages with rural outskirts.
  - Reduce forest fragmentation and the growth in suburban housing, due to the significant stormwater impact. In order to ensure Milton's growth doesn't surpass ecological limits and create irreversible damage, Milton should prepare for residential population growth in the Town Core. It is important that Milton focus on making downtown core more walkable, attractive (green), and provide vibrant social opportunities for young families.
  - Identifying natural areas for protection in town plan. The Lake Champlain Basin Program identified 575 acres of important wetlands in Milton, and encourages town to adopt a Regional Planning Commission-approved flood resiliency plan to ensure long term protection of wetlands and riparian areas.
  - According to the 2002 Milton Watercourse Buffers document, the stormwater goal for the Town Core is to "lessen the specific sites stormwater runoff while increasing the areas [population] density" (Milton Best Management Practices for Stormwater Control and Watercourse Buffers, 2002).
  - Developing stricter riparian buffer regulations in the UDR to encourage vegetation surrounding rivers will stabilize river banks and treat stormwater runoff before it reaches the Milton's rivers.

## 2. Retrofitting of Existing Developments.

Within existing developments, install stormwater retrofits, starting with high impact, cost-effective locations through a Stormwater Master Planning Process.



As discussed in the *Regulations and Permits* section, state stormwater permits only regulate a small fraction of the impervious surfaces in Vermont. A majority of impervious surface construction happened prior to 2002. Thus, there are large quantities of sub-jurisdictional properties that have little to no stormwater controls. These existing impervious surfaces require GSI retrofits to mitigate runoff. Installing structural GSI practices on existing unregulated or under-regulated properties is the most important action Milton can take to reduce harmful stormwater runoff. High-impact, cost-effective locations for GSI retrofits should be targeted first, and can be identified in a Stormwater Master Planning process.

### 3. Stormwater Master Plan.

Prepare and implement a town-wide stormwater master planning process with assistance from technical experts.

To cost effectively implement GSI retrofits in Milton, Milton should begin the process of Stormwater Master Planning. Effective planning prompts strategic and preventative approaches rather than reactionary approaches; stormwater master planning is a preventative approach. The Vermont Department of Environmental Conservation (DEC), the Vermont Planning Information Center, and neighboring municipalities recommend that municipalities engage in stormwater master planning. Milton was urged to take part in Stormwater Master Planning in the Lamoille Tactical Basin Report based upon Milton's relatively high population and impervious surface cover within the Lamoille basin (LRBP, 2016, pp. 58). The DEC emphasizes the plans' importance on their website: "Stormwater master plans can prevent problems from happening either by mitigating impacts before they create problems or by avoiding the creation of problems; in other words, prevention is cheaper than restoration."

An important and central element of Stormwater Master Plans is a prioritized list of projects. The process of identifying stormwater problem areas involves community input, public works staff, engineers, and Tactical Basin Plans. Once a list of problem sites is generated, a significant study takes place where water quality specialists and river engineers assess the sites and rate the potential benefit of GSI retrofits based on multiple criteria (urgency, phosphorus reduction potential, projected cost of retrofits, etc.). Projects identified as priorities based on this process meet urgent needs and provide cost-effective phosphorus reduction services.

Jenna Calvi of the City of Burlington recommends Milton participate in Stormwater Master Planning as a way to be better prepared with state permits. Calvi notes that "in order to meet the goals that the DEC and EPA have set, the state might need to come down pretty hard" on municipalities (Calvi, personal communication, June 22, 2017). She proposes Stormwater Master Plans as a helpful first step, "because they give towns the opportunity to do their own strategic planning" to meet state requirements while considering community input and alignment with Town Plans.

To give a sense of how this has worked for another community, we can look to Williston's Watershed Improvement Plan. This plan is essentially a Stormwater Master Plan. With community

input, Williston identified 74 problem sites. With the help of environmental consultants, Williston prioritized problem sites based on relative impact, frequency of problem, current conditions, and urgency. The average scores for these categories determine if the project is high or low priority. The next step was ranking the high-priority items by implementation-readiness, which is based on constructability, ease of operation, and the anticipated pollutant abatement including sediment and volume. The result of this extensive process is a list of projects that will have the most significant stormwater mitigation for the lowest cost. This planning process is incredibly valuable, and something Milton should invest in in order to make informed decisions and identify actions that will have the highest phosphorus load reduction per dollar spent.

Another important result of Master Planning is that this level of watershed planning is valued in the selection criteria for Clean Water Fund grant opportunities. *For more on grant eligibility, see “Identify Funding”.*

Many communities with Stormwater Master Plans engaged the support of environmental consultants. In Williston, for example, after the lengthy prioritization process, the town hired Stone Environmental, an environmental consulting agency, to design the first steps of top priority restoration projects. However, there are elements of the Master Planning process that can begin with Town staff, for later handoff to water quality experts. There are numerous resources available online to assist municipalities in creating these plans. The VT DEC hosted a “Stormwater Master Planning” webinar that is now on YouTube, the Lamoille Tactical Basin Plan recommends a template for Milton specifically to use, the EPA provides a comprehensive community stormwater planning guide, and there are Stormwater Master Plans for several surrounding municipalities that can help inform Milton’s approach to Stormwater Master Planning. Additionally, there is some degree of technical assistance available through the State government, such as channel management consultation from VT DEC River Engineers, soil test kits through UVM Extension, and aquatic habitat assessments through VT Fish and Wildlife.

Tactical Basin Planning is a first step to assist communities in prioritizing sections of rivers that are ecologically threatened. The State considers Tactical Basin Planning to be an integral component of helping communities identify important natural features, as well as general locations for stormwater retrofits. The Lamoille Tactical Basin Plan identified a half-mile stretch of Streeter Brook as stormwater stressed, meaning that without mitigation it could result in a stormwater impaired waterway. Milton’s Watercourse Buffer report from 2002 also identified specific watersheds in Milton where stormwater poses significant risks to water quality: Streeter Brook, small streams in the Town Core (all of which flow to the Lamoille River), Allen Brook watershed, and Mallets Creek watershed. A more thorough analysis is needed to identify specific sites for stormwater retrofits within these watersheds.

The EPA Community Resilience Planning Manual is a great place to start. This planning manual is user-friendly and well suited for Town volunteers, interested community members, and staff. This tool lays the groundwork for a participatory, resourceful plan. I put this planning manual in the appendix for those readers who are looking for an avenue for involvement in Milton’s stormwater management (A6). Stormwater Master Planning is essential to developing a proactive, cost-effective, and publicly engaging stormwater program in Milton.

See below for more resources on Stormwater Master Planning:

EPA Community Resilience Planning Manual: [https://www.epa.gov/sites/production/files/2016-10/documents/draftlongtermstormwaterguide\\_508.pdf](https://www.epa.gov/sites/production/files/2016-10/documents/draftlongtermstormwaterguide_508.pdf)

VT Stormwater Master Planning Guidelines:

<http://www.vpic.info/Publications/Reports/GreenInfrastructure/VermontStormwaterMasterPlanningGuidelines.pdf>

#### 4. Stormwater Advisory Committee.

Engage a citizen advisory committee to steward the master planning process.

Karen Adams from the Town of Colchester said that their citizen-lead Stormwater Advisory Committee (SWAC) was pivotal to the development of their stormwater utility. Colchester's SWAC guided the formation of the utility. They researched the actions of surrounding municipalities that recently developed stormwater utilities (South Burlington, Burlington, and Williston). The committee made recommendations based on that research, supported staff in drafting the ordinance and budget amendments, and provided information and education on the utility to the broader community.

The formation of a SWAC is an important step to ensuring that policies are representative of the public's diverse ideas and interests. (*MS4 Minimum Control Measure 2: Public Participation*). At this time, Jacob Hemmerick, Milton Planning Director, is determining the feasibility and interest amongst Infrastructure Standards Committee (ISC) for transforming the ISC into Milton's SWAC and Capital Improvement Planning Committee. If there is interest, the ISC is uniquely suited for this dual-function committee because the ISC is the only Town organization that includes at least one member of every voluntary board and commission. Thus the committee could bring a variety of voices together, and promote collaboration and communication in Town governance.

#### 5. Stormwater Manager.

A full-time manager can oversee municipal education, development, and maintenance of stormwater retrofits and implementation of LID/GSI.

In order to stay in compliance with Milton's MS4 permit, and prepare for future MS4 requirements, Milton should hire a stormwater program manager. The potential duties of a Stormwater Program Manager are listed below:

- Train municipal staff on GSI stormwater system maintenance
- Stay up-to-date on developments in GSI in VT and New England
- Provide staff support to Stormwater Advisory Committee (SWAC)
- Conduct site plan reviews and inspections for all locally permitted projects for compliance with Erosion Control Practices and Stormwater Management (UDR Section 3009 and 3010)
- Manage stormwater program budget, apply for and administer Clean Water Fund grants

- Supervise maintenance of stormwater systems (both GSI and gray infrastructure)
- Facilitate public interface with Stormwater Master Planning Process
- Facilitate stormwater permit ownership transfers (private to public)
- Serve as Milton’s stormwater expert when miscellaneous stormwater-related tasks arise

While Milton can continue to meet no more than the minimum control measures for its MS4 Permit each year, scattershot approaches (ex. one rain garden here, another street sweep project there) will be significantly more expensive. Managing a cost-effective, publicly acceptable stormwater program will require significant administration. According to Jenna Calvi, the City of Burlington’s Stormwater Program Manager, a majority of Burlington’s stormwater program budget is spent on administrative costs. Calvi shared that Burlington’s stormwater program has annual budget of \$1.5 million—63% of which is dedicated to administrative, operational, and maintenance costs<sup>6</sup>. A stormwater manager is needed to manage the people and projects that Milton should invest in.

## 6. Employee Training.

Train municipal employees to build awareness of stormwater issues, and build knowledge on implementation and maintenance of public GSI projects

Due to MS4 requirements, municipal staff is required to attend an annual training surrounding stormwater management and illicit stormwater discharges (*MS4 Minimum Control Measure 3: Illicit Discharge Detection and Elimination*). The Resilient Right of Way (RROW) team will facilitate municipal employee training in the coming months to fulfill the 2017 MS4 reporting requirement. In preparation for this training, Milton should request the RROW team’s assistance developing materials for future municipal training sessions, such as an adaptable agenda, and preparation notes for future facilitators. If Milton can utilize the RROW team’s support in developing a training structure for use in future years, then Milton will save time and resources. Milton can save additional time and resources by identifying a staff member to serve as Milton’s “stormwater expert”. This type of in-house knowledge can be applied to the facilitation of municipal staff trainings, as well as various other stormwater-related projects, such as annual MS4 Permit reporting.

## 7. Maintenance Plan.

Develop maintenance plan for GSI projects, consider life-cycle costs when weighing options for stormwater infrastructure

Documentation of stormwater maintenance practices are required for state permits, maintenance costs account for substantial portions of stormwater system live cycle costs, and

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<sup>6</sup> Only 37% of the city’s budget is directed to Capital improvement. Of that capital, 70% is targeted towards reinvestment in existing aging infrastructure, with only 30% of capital directed towards Green Stormwater Infrastructure retrofits (Jenna Calvi Testimony on Stormwater Utilities for VT State Treasurer’s Report, 2017).

Perceived maintenance burdens of GSI practices pose barriers to the implementation of GSI (Weiss, 2007 as cited in Erickson et. Al., 2010, Houle et al., 2013). Maintenance costs of stormwater systems account for substantial portions of stormwater system life cycle costs, thus assessing the costs and benefits of changing maintenance operations from gray to green infrastructure is essential to implementing GSI. There is an increasing body of literature responding to the need for long-term life cycle cost information for stormwater treatment practices (Powell et al., 2005 as cited in Houle et al., 2013).

GSI systems are less costly and require less time and effort to maintain, but still achieve greater pollutant load reductions for phosphorus, nitrogen, and sediment (J. J. Houle et al., 2013, Erickson et al. 2010). An EPA study found that GSI maintenance demands might be higher than maintenance demands for gray infrastructure. However, since GSI can take the form of routine landscaping and doesn't depend on heavy equipment, GSI practices can save money in the long term (Environmental Protection Agency, 2007). James Sherrard, Stormwater Program Manager for the Town of Williston, said that many people are concerned about the maintenance demands of GSI, but he has found that they are comparable. In the long run, Sherrard projects that green stormwater infrastructure will be much more cost effective than gray infrastructure.

For a cogent analysis of GSI and gray infrastructure maintenance costs, Houle et. Al. provides a comprehensive breakdown of maintenance cost determinants, including labor hours, percentage of the time that experts/engineers are required on site, equipment costs, and predictability. "Comparison of Maintenance Cost, Labor Demands, and System Performance for LID and Conventional Stormwater Management" by Houle et. Al. is located in the appendix (A5).

The EPA strongly recommends that municipalities develop maintenance plans to reduce staff burdens. Tom Depeitro, South Burlington Stormwater Superintendent, encourages both a maintenance plan and an equipment schedule so that a municipality can effectively share resources. The EPA recommends that municipalities use online life cycle cost calculator tools to demonstrate understand the true cost of GSI vs. gray infrastructure maintenance; URLs are listed below.

Life cycle calculator tools:

[www.werf.org/bmpcost](http://www.werf.org/bmpcost)

<http://greenvalues.cnt.org/national/calculator.php>

City of Seattle's GSI Maintenance Plan for reference:

[http://www.seattle.gov/util/cs/groups/public/@spu/@usm/documents/webcontent/spu02\\_020023.pdf](http://www.seattle.gov/util/cs/groups/public/@spu/@usm/documents/webcontent/spu02_020023.pdf)

City of Portland's Maintenance Guide For Private Property Owners:

<https://www.portlandoregon.gov/bes/article/54730>

Comparison of Maintenance Cost by Houle et. Al. (also in Appendix: A5):

[https://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/Houle\\_JEE\\_July-2013.pdf](https://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/Houle_JEE_July-2013.pdf)

## 8. Public Ownership.

Consider taking over private stormwater permits and systems to ensure compliance with MS4 permit.

Milton currently has a large number of stormwater systems under private ownership. This complicates the process of monitoring and maintenance to ensure compliance with the MS4. Milton should consider the prospect of taking over new stormwater systems in order to ensure compliance with current and future MS4 permit requirements. In 2018, the MS4 permit area will expand from a

small sliver of town to the town boundary, making the Town of Milton responsible for the stormwater runoff from almost ten times as much land.

South Burlington has taken over private stormwater systems, and has learned immensely from the process of doing so. One primary takeaway that Tom Dipietro, South Burlington's Stormwater Superintendent, shared was that the City of South Burlington wasn't aware of its inability to acquire expired state permits until after the City had announced that it would, so some landowners perceived this shift a change to "the deal".

For more information, see [sburlstormwater.com](http://sburlstormwater.com)

## 9. Identify Funding.

Explore innovative funding mechanisms, including a utility fee.

Developing a robust stormwater management program will require additional financial resources. An appropriate funding strategy is to establish a stormwater fund that exists separately from Town's general fund to clarify management. Milton should identify a sustainable revenue source, and should leverage those resources to obtain and administer grants from the State of Vermont. This section discusses the feasibility of developing utility fees to fund stormwater management and introduces Clean Water Fund grant opportunities.

### Implement a Stormwater Utility Fee

In June 2017, I interviewed four municipal stormwater managers<sup>7</sup> in Chittenden County that currently operate stormwater utility fees (also called service fees). A stormwater utility fee is a funding mechanism for stormwater programs that charges land owners based on their properties' contribution to stormwater runoff. The fee is billed to landowners in the same format as a municipal water/sewer bill. Utility and service fee programs in Williston, Burlington, and Colchester are modeled after South Burlington's utility fee structure, which assigns a flat rate fee for small residential properties (single-family house, duplex, and triplex) and tiers the fee rates for larger developments (commercial, industrial, large multifamily units) based on the amount of impervious cover on the lot.

All four municipalities are MS4 communities, and the utility fees fund projects necessary to meet their MS4 permit requirements and impaired waterway regulations. I interviewed regional stormwater managers to learn how these funding mechanisms were developed, implemented, and to gather lessons learned from early adopters.

According to James Sherrard, Town of Williston Stormwater Manager, billing properties based on impervious surface cover is "the most technically and hydrologically defensible funding mechanism,". There is a clear scientific causation between acreage of impervious surface and poor water quality from stormwater runoff. Therefore the program used by these municipalities is a

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<sup>7</sup> James Sherrard of the Town of Williston, Jenna Calvi of the City of Burlington, Karen Adams of the Town of Colchester, and Tom Dipietro of the City of South Burlington

polluter-pays system, whereby those contributing the most significant stormwater burden contribute the most money to fund water cleanup. City Council President of Red Wing, Minnesota, a municipality with a similar fee structure to Williston, describes a stormwater utility fee as “the most equitable option for generating the revenue necessary to meet mandates” (*Understanding Stormwater Utility Fees*, 2015). Stormwater utility fees are currently being investigated by the State of Vermont as well.

All of these utility programs also have an incentive structure to encourage treatment of stormwater onsite. In South Burlington, Williston, and Colchester, a property owner can reduce their stormwater utility fee by up to 50 percent if they apply all available GSI technologies to their property. When properties participate in these incentive programs, the public benefits the most because stormwater is treated best at the source.

Unfortunately, in most towns, these incentive systems are significantly under-enrolled. While many large property owners could apply for the rebate program by simply submitting their engineered plans, very few do. According to South Burlington’s Stormwater Superintendent, Tom DiPietro, only 1 percent of South Burlington’s eligible property owners have entered into this program, although many would automatically qualify for some rebate because they are meeting the requirements in state permits for stormwater management. DiPietro projects that low enrollment is caused by lack of awareness of the credit program and a lack of perceived benefit from enrollment. In all four municipalities, the credit program is not available to those paying flat fees (all residential uses), thus it is primarily geared towards commercial and industrial uses. In addition to this incentive structure, Burlington has an incentive program that targets residential property owners called BlueBTV.

BlueBTV is a grant-funded, non-profit program that provides technical assistance, public outreach, and administrative management of the City of Burlington’s fee rebate system. BlueBTV was formed in partnership between the City of Burlington Water Resources Division and Lake Champlain International, a local non-profit. Through this program, Lake Champlain International offers technical assistance to property owners seeking enrollment, and ultimately provides them with a check in the mail for installing GSI on their properties.

#### How did they develop their utility fees?

South Burlington was the first municipality in the state to adopt an ordinance for a stormwater utility fee in 2005. Nearby towns of Burlington, Williston, and Colchester have all taken South Burlington’s lead, and each has developed ordinances involving the same fee structure. All four of the programs started with a significant financial investment in feasibility studies and project planning. However, each successive program that jumps on-line has benefitted from the knowledge gained by its predecessors. All of the aforementioned municipalities have impaired watersheds, thus the state requires higher levels of monitoring, which means more expensive permitting requirements.

#### What were lessons learned that could assist Milton in developing a utility fee?

For utility development, I received a many recommendations from surrounding municipalities about lessons learned from the implementation of a utility bill. I included them below in a list



format. The stormwater manager's name is provided beside each recommendation provided by that person.

- Public Education
  - Form a SWAC, send FAQs and informational letters with first two billings (James Sherrard of Williston)
  - Major outreach push is necessary. Colchester had selectboard topics, interviews with local TV stations, messages from the Town Manager's office, etc. (Karen Adams of Colchester)
  - Meet with big impervious surface contributors early in the process. Show them their maps, explain the fee structure, and provide general information about stormwater issues. Also cue them into opportunities to reduce their fees by 50% by implementing GSI practices on their property. (Karen Adams of Colchester)
- Studies
  - Feasibility studies are expensive, but necessary (Tom DiPietro of S. Burlington, James Sherrard of Williston, Karen Adams of Colchester)
  - Impervious surface mapping, indexing to tax map, and quality checking for accurate billing (Karen Adams of Colchester, Tom DiPietro of South Burlington)
    - Private roads and homeowners associations pose a responsibility issue, Colchester decided to split impervious surface of the road or neighborhood resources evenly between the number of properties using those facilities.
    - This was an expensive and lengthy process and required consultant help, but now they have reliable data.
    - Some municipalities decide to count gravel roads as impervious while others do not. Colchester counts gravel as impervious because they have equal density to paved roads because of compaction.
    - S. Burlington found that they didn't need to update their impervious cover maps every year. They discovered that major changes are captured in zoning permits. Instead, they now update every five years.
- Administration
  - High cost, majority of funding goes to administration with some funding to maintenance and very little to new stormwater retrofits (Jenna Calvi of Burlington)
  - Williston's Stormwater Program Manager spends a significant amount of his time applying for State grants. He says once the department identified the problem areas, it became a question of managing and funding the projects. (James Sherrard of Williston)
  - Block out first 2 months for stormwater manager and administrative staff to answer frantic phone calls and emails about new bill (James Sherrard of Williston). Tom DiPietro of South Burlington recommends up to a year of extra staffing (temporary staff and consultants).

- Inform front-line staff (for example, clerks, finance, and administrative assistants) of simple facts to answer quick questions. According to Sherrard, Williston provided front-line municipal staff with Frequently Asked Questions (FAQ) sheets.
- Developing a human resources plan and equipment schedule to identify Public Works staff to maintain stormwater, while others manage other aspects of road construction. This is important to sharing equipment between public works and stormwater technicians (Tom Dipietro of South Burlington).
- Billing
  - For communities where some residents are on private wells and septic systems, a separate stormwater bill should be delivered to everyone. In Burlington, there are no private wells or septic systems, thus the stormwater bill is easily tacked onto water/wastewater bills (Jenna Calvi of Burlington).
  - Determine who in municipal building will collect payments (Town clerk? Public Works or Planning & Zoning?). According to Adams, The Town of Colchester decided Town Clerk would collect payments, and the Town bought a hand-scanner to reduce staff burden of entering data into a computer.
  - Billing cycle was delayed 6 months because Colchester's printing vendor wasn't prepared for the volume of business (Karen Adams).
  - S. Burlington initially struggled with billing inaccuracies, but invested in additional studies for accurate impervious surface data (Tom Dipietro).
  - Billing town-owned impervious surface can be complex, since town-owned roads are typically the largest impervious surface land owners (Karen Adams of Colchester). Colchester decided that Town would pay the fee like any other landowner in order to demonstrate to its constituents a sense that everyone is "in it together" (Karen Adams).
  - Billing tax-exempt properties such as public schools and churches was difficult at first, because those managing the tax-exempt properties needed to adjust to a new bill (Tom Dipietro of South Burlington).
- Political Will
  - It worked well for Colchester to initiate massive outreach campaign before Selectboard votes on the utility proposal (Karen Adams).
  - Meeting with big Impervious Surface Unit (ISU) payers before public meeting and vote by Selectboard to adopt stormwater utility was important, because the people with the most to lose from the creation of a utility had full information and their voices heard earlier in the process (Karen Adams of Colchester).
- Agriculture:
  - Finding the right approach to billing the agricultural community is important. According to Karen Adams, many farms have up to 10 times as much impervious surface as a typical residential unit (Colchester). Thus, although farms are listed as residential uses in the land records, they should be treated differently due to their land use impacts. Colchester and S. Burlington have chosen thus far to bill these

properties just as any commercial or industrial property. Williston took an innovative approach to support local agriculture by reducing the stormwater fees by 50% for any agriculture operation, and then offering an additional 40% fee reduction for farms implementing state Required Agricultural Practices (RAPs) to improve water quality. Thus if farmers in Williston implement State RAPs, they receive a 90% stormwater utility fee reduction (James Sherrard).

### Considerations For Milton

- If Milton were to pursue a stormwater utility and associated fee collection, Milton would have access to experts who have already jumped some of the most significant hurdles.
- There could be potential opportunities for Milton to team up with a nearby municipality to share resources in administering a utility. The City of South Burlington is currently assisting the Town of Shelburne in developing a utility program. Shelburne is contracting stormwater management services (such as maintenance, equipment, technical expertise, and management) from South Burlington, and the partnership has so far been beneficial to both parties. For more information: [https://www.epa.gov/sites/production/files/2017-01/documents/session\\_2\\_wheeler.pdf](https://www.epa.gov/sites/production/files/2017-01/documents/session_2_wheeler.pdf)
- Developing this funding source would help Milton stay ahead of regulations and prepare for additional stormwater management efforts from new regulations and the potential EPA classification of an impaired waterway.
- There might be pushback from property owners about paying additional fees to the Town. However, if the Town develops a robust credit system, such as Burlington's BlueBTV system, the town can present opportunities for fee reduction to those who install GSI stormwater treatment practices on their properties.

### Other Funding Tools

While there are additional stormwater project funding mechanisms, such as watershed-level phosphorus trading and stormwater impact fees, they have only been used in Vermont on impaired watersheds (Pierce, 2017). Specifically, they have been used on impaired waters that don't yet have TMDLs assigned, so no net contribution of phosphorus pollution is allowed. At this time, utility programs the primary method that municipalities raise revenue explicitly for stormwater programs. Most municipalities in Vermont fund their stormwater improvements out of the Town or City's general fund. There are several benefits to having a self-sustaining stormwater program instead of a program dependent upon parts of a municipality's general fund, such as grant selection.

### Grant opportunities

The State of Vermont has allocated significant funds to water quality efforts as a result of Act 64 and the State Treasurer's Report. State permits, such as the MS4 permit and the Municipal

Roads General Permit<sup>8</sup>, require that municipalities take action to reduce their stormwater impact. Clean Water Act grants, delivered by the Agency of Natural Resources and the Agency of Transportation provide resources for municipalities to get the work done. Most include a 20% or 50% municipal match, as well as some degree of planning and site design to obtain project funding.

Municipalities are only considered eligible when their projects land on a state database termed the “Go List”, denoting a project’s status as eligible for capital funds, ready for final engineering design and/or construction, prioritized for nutrient and sediment pollution abatement, and sponsored by municipalities. This eligibility requirement underwrites the importance of stormwater master planning, because a stormwater master plan identifies priority locations for pollution abatement, and can help get those priority project sites to the final stages of planning and ready for construction.

One of these grants, the Clean Water Block Grant, also reflects these values. In the June Chittenden County Regional Planning Commission Clean Water Advisory Committee, Karen Bates of the DEC emphasized the following selection criteria for grant applicants: projects have to prove their priority above other potential projects, have an estimated phosphorus reduction impact, prove their cost-effectiveness, and demonstrate project-readiness with political buy-in and a long-term maintenance plan. Many of those criteria would be satisfied through some level of stormwater master planning. The most significant criterion (worth 40% of the selection value) is a municipality’s capacity to administer a block grant. The addition of a stormwater program Manager to the Town of Milton Public Works staff would provide the capacity to administer a block grant. As Milton’s stormwater program currently stands, that administrative capacity isn’t as strong.

The selection criteria for the largest water quality grants for municipalities demonstrate the benefit Milton could gain from hiring a stormwater manager and participating in a Stormwater Master Planning process. A 2017 chart with all Clean Water Act funding opportunities is attached in Appendix 1.

#### 10. Public Demonstration & Leadership.

Implement GSI public demonstration sites to spread awareness and garner support (public property, high visibility, low cost).

##### Consider Public Demonstration Sites in Capital Improvement Plan

The objective for identifying public demonstration sites is to locate publicly-owned land where green stormwater infrastructure could positively impact water quality while serving as a tool for public education about stormwater. In addition to improving water quality, helping the town meet state and federal requirements, and adding aesthetic value, public demonstration sites build important public awareness and support prior to regulatory change.

##### Criteria to be used to identify sites for public demonstration:

- Public site with foot traffic

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<sup>8</sup> The Municipal General Roads Permit (MRGP) is not required for MS4 communities; instead, the 2018 MS4 permit will be amended to incorporate new road requirements.

- Limited traffic interference during installation
- Town-owned land (right-of-way or municipal campus)
- Proximity to intercept stormwater runoff from nearby impervious surfaces without significant grading
- Low cost installation and maintenance

Based on these criteria, preliminary research, and a basic understanding of the functions of GSI practices, I recommend the following locations for GSI retrofits. Each of these projects requires a stormwater system designer or engineer to determine road grade, the average stormwater volume leading to the ditch, proximity to utilities and water table depth, among other important design specifications. Additional conversations with the Public Works department are necessary to determine if there are any reoccurring issues with stormwater systems in the area; development of a maintenance plan for new systems, and construction alignment with the Milton Public Works Specifications.

Possible demonstration sites identified (not comprehensive):

1. Cherry Street-paved ditches, clogged culverts, steep slope (Figure 5)
  - a. Concerns: The paved ditching along Cherry Street direct stormwater to a culvert that runs under River Street and outfalls into the Lamoille River. There is no treatment for the stormwater coming down Cherry Street, thus pollutants from the road and nearby lawns and driveways flush into the Lamoille River during storms. The stretch of Cherry Street pictured below (Figure 5) is particularly worrisome because the steep slope increases the speed of the stormwater runoff, threatening riverbank destabilization and flood hazards downstream. However, under some circumstances, paved ditches are the best fit for steep slopes because although they might cause erosion downstream, they prevent the erosion of the ditches themselves (Becky Tharp, personal communication, August 5, 2017).
2. School Street-paved ditches, ditching runs directly into ravine. (Figure 6 and 7)
  - a. Concerns: The paved ditching along School Street appears troubling because road runoff cannot infiltrate into the ground, posing water quality concerns and flood concerns if gray infrastructure doesn't function properly. On one side of School street, paved ditches direct stormwater to a series of catch basins. On the other side of the road, a paved ditch veers off the road and directs runoff to a Lamoille River stream. If soil types and water table depth permit, the installation of bioswales and drywells along both sides of the road might help treat stormwater before it reaches the nearby stream.
3. School parking lot- large parking lot
  - a. Concerns: The Milton High School parking lot would serve as an excellent public demonstration site. The installation of a bioswale or another infiltration practice might help reduce the environmental impact of the impervious lot. Bioretention and rain gardens are highly effective at removing nutrients and contaminants from stormwater, while providing aesthetic values and educational opportunities.

4. Municipal campus- medium-sized parking lot, in close proximity to paved road.
  - a. Concerns: The municipal building generates significant foot traffic, making it a great location to showcase green stormwater infrastructure. Rain gardens at the edge of the municipal parking lot would help treat runoff while providing aesthetic value and educational opportunities to municipal staff, town residents, and library program attendees.



Figure 5. Cherry Street paved ditch on steep slope.



Figure 6. Paved ditch on School Street.





Figure 7. Paved ditch School Street directs untreated stormwater to Lamoille River tributary.

## 11. Engage Regionally.

Participate in Green Infrastructure Roundtable and other public awareness groups and projects.

Town should identify an individual in the municipal building to serve as a stormwater expert, or consider hiring someone to do this job. The Green Infrastructure Roundtable can assist in this process of building and retaining stormwater knowledge. Milton's responsible staff and SWAC should participate in the Green Infrastructure Roundtable. The Green Infrastructure Roundtable (GIR) is a volunteer group of public and private individuals discussing cutting edge green stormwater science and policy.

Follow this link to join: <https://groups.google.com/forum/?fromgroups#!forum/green-infrastructure-roundtable>

## 12. Public Education and Outreach.

Develop a pamphlet to send with new permits, share information on updated Town website, host movie screening.

- Staff at the Town of Milton should create some form of pamphlet to send zoning applicants home with. This serves as a tool for ensuring proper site plan review (*Minimum Control Measure 4: Construction Runoff*), and helps build awareness of stormwater as an environmental, economic, and public health hazard.
  - The content of the pamphlet could be parts of the executive summary of this report, information about Milton's impervious runoff, and some basics of GSI solutions to gray infrastructure problems.
- Host movie showing of "What's Your Watermark?", a free 37-minute documentary about Lake Champlain water quality, <http://whatsyourwatermark.com/>.
- Create an engaging webpage for stormwater management on Milton's website that includes various external links to regionally-relevant water quality outreach materials, such as the CCRPC project that Milton funds "Rethink Runoff", Chittenden County Stream Team, and other online educational resources. This would offer opportunities to Milton residents and property owners to learn more and get involved in mitigating the impact of stormwater on Lake Champlain.
  - Rethink Runoff (educational)- [RethinkRunoff.org](http://RethinkRunoff.org)
  - Chittenden County Stream Team (public involvement)- <http://rethinkrunoff.org/get-involved/get-involved-stream-team/>



### 13. Make it Predictable.

Clarify and streamline stormwater site plan review, inspections, and enforcement for all new developments according to Milton's Unified Development Regulations.

- Unified Development Regulations
  - Applicants required to use GSI sizing tool<sup>9</sup> to design and fit stormwater control practices to increased impervious surface for greater than 5,000 sq ft impervious cover (UDR Section 3010)
    - ZA could deny permit if BMPs are not proposed (3010.D).
  - Applicants required to meet Erosion Control Practices for any and all earth disturbance (UDR Section 3009B), whether a zoning permit is required or not.
  - Construction activities disturbing more than 10,000 feet of soil have to prepare a professionally designed Erosion Control Plan (UDR Section 3009C).
  - Milton should expect an influx of new erosion control plans in comparison to prior years due to new regulations targeting smaller projects. According to Milton's 2014 MS4 permit, in 2014 only 2 projects disturbed 1 acre or more of soil, thus the Town of Milton only reviewed 2 Erosion Control Plans.
- Implementing UDR: Streamlining the Application Process
  - All zoning permit applications
    - Attach Erosion Control requirements page with check boxes beside each required practice. In order for the ZA to approve the application, applicant must agree to conform to all Erosion Control Practices listed in UDR Section 3009.D. Alternatively, this page could look more like Burlington's Small Project Erosion Prevention and Sediment Control Plan document, where open-ended leading questions require that applicants write down particular practices they will use to meet erosion control requirements (see Appendix 3).
    - Attach Post-Construction Soil Depth and Quality regulations (UDR Section 3010.F) required for any new impervious surface cover.
  - If applicant proposes disturbing 10,000 ft<sup>2</sup> or more earth surface during construction...
    - If proposed project will disturb more than 10,000 ft<sup>2</sup>, town directs applicant to DEC standards for Erosion Control Plans.
    - Town engineer and/or Zoning Administrator review Erosion Control Plans and inspect development sites during construction.
    - Town engineer and/or Zoning Administrator comments on practices, makes recommendations where appropriate, and issues zoning permit based on adequacy of practices (*Minimum control measure 4: Construction Runoff*)

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<sup>9</sup> GSI Sizing Tool for Small Projects is a VT DEC document for adequately designing and installing GSI practices for sites draining up to 10,000 ft<sup>2</sup> of impervious surface. It is an excel-based tool with a paper "fact sheet" guide: <http://www.vpic.info/GreenInfrastructureCalculatorsAndSizingTools.html>

- If applicant proposes adding 5,000 ft<sup>2</sup> or more impervious surface to the property post-construction...
  - If proposed project will create between 5,000 ft<sup>2</sup> and 10,000 ft<sup>2</sup> of impervious surface, the applicant must use GSI Sizing Tool to develop a stormwater management plan.
  - If proposed project will create more than 10,000 ft<sup>2</sup> of impervious surface, the applicant must use the Vermont Stormwater Management Manual to guide site design.
  - For any project creating more than 5,000 ft<sup>2</sup> of impervious surface, applicants must meet Section 3010.F stormwater control Best Management Practices (BMPs).
    - Planning office will provide a list of stormwater control practices for these sites and request that applicants sign a form stating that they have complied.
  - Town engineer and Zoning Administrator review Stormwater Management plans and inspect development sites post-construction.
  - Staff comments on practices, makes recommendations where appropriate, and issues zoning permit based on adequacy of practices (*Minimum control measure 5: Post-Construction Runoff*)
- To plan for incoming personnel burden, consider a hiring new staff member to take on the new influx of applications, site plan reviews, inspection and enforcement. See *Recommendation 5: Stormwater Manager*.

## THE ECONOMICS OF CLEAN WATER

### The Consequences of Inaction

While it is common practice to compartmentalize environment and economic problems and solutions, the truth is that the two are inextricably linked. We cannot support a healthy economy in Milton, or Vermont in general, without balance between our built and natural environments.

### Recreation and tourism

Angling, boating, and swimming are part of VT's recreational heritage. Water-related activities define our quality of life and significantly support our economy. Lake Champlain water quality is important for recreation and tourism in Milton, especially since Milton's economy is deeply interwoven into the regional economy. Recreation and tourism activities depend on healthy ecosystems and waterways. According to the Lake Champlain Basin Program, "non-consumptive" recreation uses of the Basin's natural resources, such as boating, hiking, and cross-country skiing, are all made more attractive in the context of excellent water quality, abundant wildlife, and wildlife habitat. Additionally, consumptive recreation and tourism uses such as fishing and blueberry picking depend on the same healthy ecosystems.

In the state as a whole, recreation and tourism is one of Vermont's important economic drivers. By an executive order in June of 2017, Governor Phil Scott created a task force to study methods for nourishing Vermont's outdoor recreation economy. Governor Scott's recent action will likely continue to develop this natural resource-based economic sector, highlighting the importance of maintaining healthy ecosystems in VT.

According to a Vermont Department of Tourism and Marketing study, visitor spending generated \$318 million in tax and fee revenues in 2013. That \$318 million contributed \$115 million to the general fund, \$188 million to the education fund, and \$15 million to the transportation fund. These revenues speak to the value of Vermont's lakes and rivers as state assets (Jones, 2013).

Trevor Crist, CEO of Inntopia, a Stowe-based business, says that outdoor recreation is "part of the lifestyle that we have as one of the benefits of coming to work at Inntopia, so it's definitely ingrained in our corporate culture" (Cross, 2017).

Lake Champlain's water quality issues are most present in the minds of Vermonters and tourists alike when beaches close due to water pollution. Of the 35 public beaches on Lake Champlain, 23 were closed two or fewer times between 2012 and 2014 due to toxic levels of water pollution (State of the Lake, 2015). Milton's Sandbar State Park was closed 4 times between 2012 and 2014 due to water quality issues.

When the quality of Lake Champlain suffers, the surrounding economies suffer as well. According to Patricia Moulton and Deb Markowitz, former secretaries of the Agency of Commerce and Community Development and the Agency of Natural Resources, Vermont receives \$2.5 billion

from tourism each year, and they estimate that tourist activities “in and around Lake Champlain” generate about \$300 million of those expenditures (Moulton and Markowitz, 2015).

With all of the spending occurring in the lake region for tourist activities, more jobs are required to sustain the recreation and tourism industry. For each dollar of labor income required within the lake-related tourist sectors, an additional \$0.57 in labor income is distributed in the regional economy through indirect and induced economic impacts (LCBP, 2016). In terms of employment opportunity, every new job related to the lake tourism economy creates an additional 0.4 jobs to support those indirect and induced activities (LCBP, 2016). The revenues generated by activities surrounding the lake benefit Milton in indirect but significant ways because of Milton’s role in the Chittenden County economy, and the surrounding economies.

When discussing the specific impact for a Lake Champlain shoreline town, there appears to be a strong link between total economic value and water quality. One way to measure water quality is based on water clarity (also referred to as turbidity). Turbid waters indicate algal growth and/or high levels of suspended sediments, which can carry excess nutrients (such as phosphorus), metals, or other potentially harmful pollutants. According to economic projections, in towns surrounding Lake Champlain, a decrease in 1 meter of water quality during the months of July and August is estimated to equate to the economic loss of 195 full time employees and 12.6 million reductions in tourism expenditures, amounting to a total economic reduction of nearly \$16.8 million (Voigt B., Lees J., Erickson J., 2015).

In addition to the Lake’s economic value, the Lamoille River is a strong economic asset for the Town of Milton because of recreational activities. There are three Vermont Fish and Wildlife Fishing Accesses in Milton, one on Lake Champlain in the Sandbar State Park, and two along the Lamoille River. Fishing is a popular sport in the U.S., and fishing-related activities contribute significantly to our overall economy. Fishing related expenditures were estimated at \$204 million in 1997 for the Basin. In 1997, the owners of the 98 fishing-related businesses within 10 miles of Lake Champlain estimated that \$5.6 million of their total income was from anglers using Lake Champlain (“People & Economy,” n.d.).

Two years ago, Milton was added to the Lamoille River Paddlers Trail. Now, the Vermont Paddlers Association considers a stretch of the Lamoille River, from Ritchie’s Ave to Milton Falls, “outstanding” Class V rapids for whitewater boating opportunities. Channel stability and good water quality are essential to the recreational opportunities that Milton offers on the Lamoille River. When Milton’s water quality declines and rivers become less stable, these activities are at risk. Milton’s economy, and the Vermont economy as a whole, is dependent on tourism and recreation. Healthy rivers and lakes with biodiverse wildlife are essential to Vermont’s tourism and recreation industries.

## Property Values and Milton’s Grant List

In addition to recreation and tourism, good water quality strongly correlates with higher property values for Milton’s homes. Property within 100m of Lake Champlain are projected to decline with the increased phosphorus loading from climate change, and property values are

projected to increase with the reduced phosphorus resulting from meeting new Lake Champlain TMDLs (Voigt, Lees, & Erickson, 2015).

In July of 2015, Georgia lakefront homes each suffered a decrease in market value caused by water quality issues. Each of the 34 homes suffered a \$50,000 value decrease, for a total of \$1.7 million decrease in Georgia's grand list. In 2008, a routine reappraisal in St. Albans Town had similar impacts for lakefront properties (Ledoux, 2015).

Based on an approximation from counting the roofs on Milton's shoreline from a Google Earth image, Milton has approximately 100 lakefront homes along Everest Rd, Lake Rd, Cold Spring Rd, and Eagle Mountain Harbor Rd. Declining water quality in Lake Champlain threatens Milton's lakefront property values and Milton's grand list.

Additionally, aesthetic improvements from GSI can increase property values. One study showed that the presence of street trees increases property values 2-10%, while another study showed residential properties adjacent to GSI practices showed 3.5-5% property value increases (Stratus, 2009; Wachter, 2004; Wachter and Wong, 2008). When Milton invests in improving Lake Champlain water quality, Milton invests in increasing property values for years to come and improving Milton's tax base and grand list.

### Cost of Noncompliance with MS4 Permit

If Milton doesn't take the necessary steps to reduce stormwater runoff, Milton risks noncompliance with the MS4 permit. If the VT Department of Environmental Conservation finds Milton is not compliant with its MS4 permit, Milton will find itself in an expensive dilemma. At the Selectboard meeting on July 10, 2017, Benjamin Heath articulated a likely process of events.

- 1st: State notifies municipality of violation and lists steps town must take to get back on track
- 2nd: If town doesn't comply, DEC will bring municipality to environmental court.

Overall, the process can take several years, and between possible fines and lawyers' fees, it gets more expensive to continue noncompliance than complying with the MS4 permit. This expensive process will lead municipalities to comply with their permits.

### Stormwater Impaired Waters

An imminent threat to Milton is the designation of a stormwater-impaired waterway. The EPA classifies surface waters as stormwater impaired if data shows a violation of one or more criteria in the Vermont Water Quality Standards for the water's class or management type. At this time, Milton is the only MS4 community in Vermont (of 15 communities) that does not have at least one stormwater-impaired waterway. If Milton doesn't step forward and change course, it is likely that Milton will join the list of impaired watersheds and face an entire new set of regulatory challenges. Many of Milton's waterways are being actively monitored through the Basin Planning process. As previously mentioned, the 2016 Lamoille Tactical Basin Plan identified Streeter Brook as "stormwater stressed", which should serve as a warning sign to the Town.

If a waterway in Milton becomes classified as stormwater-impaired, economic development might come to a halt. There is a “net zero” requirement for discharges into stormwater-impaired waters without a TMDL. Until a TMDL is established and an implementation program developed, new developed lands in the impaired watershed will need to mitigate their runoff before receiving authorization to discharge stormwater. On properties that cannot mitigate their stormwater runoff to adequate levels, land owners might have the option to either pay impact fees to Milton or install GSI retrofits elsewhere in the watershed to mitigate their land’s impact (Pierce, 2017). While this offset and impact fee program is useful in the interim, it is expensive for a municipality to establish these programs. Additionally, impact fees and watershed-level phosphorus credit trading don’t reduce phosphorus pollution; they only prevent a new development from increasing existing pollution levels. As a result, property transfers and development review are put on hold due to federal and state regulatory barriers.

MS4 communities that have impaired waterways are also tasked with additional responsibilities in their MS4 permitting process. Every other MS4 community in Vermont is required to complete Flow Restoration Plans for their permits. Flow Restoration Plans are expensive to administer, and Milton would save money if it invests in stormwater early and avoids a stream designation as impaired.

## Cost-Benefit Analysis of GSI v.s. Gray/Conventional Stormwater Infrastructure

### Quantifying Multiple Cobenefits

The Center for Neighborhood Technology developed a guide to help municipalities and developers understand the myriad benefits that GSI practices provide to communities, beyond stormwater management. The guide provides valuable tools to municipalities for quantifying the benefits of GSI. The monetary value of each practice is dependent on site variables, such as the amount of impervious surface treated, size and cost of conventional conveyance systems, property values, annual rainfall, and various other site-specific factors. This tool should be used for determining which GSI practices will produce the most value for taxpayers. These quantified benefits can then be compared with conventional costs to inform comprehensive cost-benefit analyses. A key diagram from the guide is in the appendix.

These benefits, or cobenefits, are important to consider when assessing the financial feasibility of implementing GSI. Ecosystem health and prosperity doesn’t exist separately from human health and prosperity. In our current economic system, most transactions don’t account for the environmental impact of the product or service sold. Monetizing ecosystem services is an attempt to inform economic decisions with biophysical constraints of the planet.

GSI can provide a multitude of ecosystem services. For example, the Center for Neighborhood Technology reports that planting trees reduces water treatment needs, improves water quality, reduces grey infrastructure needs, reduces flood risk, increases groundwater recharge, reduces energy use, improves air quality, reduces atmospheric CO<sub>2</sub>, reduces urban heat island effect, improves aesthetics, increases recreational opportunities, reduces noise pollution, improves

community cohesion, improves habitat, and cultivates public education opportunities. For a more comprehensive list of these ecosystem services, see the Center For Neighborhood Technology figure in Appendix 4.

Additionally, studies on green stormwater infrastructure have linked green infrastructure to social benefits including lower crime rates, increased feelings of safety, better health, better mental health, reduced stress, and increased social capital (Meerow & Newell, 2017). These findings make environmental injustices and the inequity in access to green space for different racial and economic minority groups so harmful. Resources for helping to site GSI to alleviate social inequity can be found in *References*. The ecosystem services promoted by GSI help foster more cohesive and resilient communities in the face of climate change, while improving community livability.

### LID Cost-Effectiveness Case Studies

In 2010, New York City developed two strategic plans for managing stormwater runoff. They called one a “gray” strategy because it is based on conventional/gray infrastructure. They called the other a “green strategy”, because it combined some conventional/gray infrastructure practices with Green Stormwater Infrastructure practices. When comparing the two strategic plans, they found that although installation costs for GSI were higher than conventional, the lifecycle and maintenance costs of Green Stormwater Infrastructure were lower than conventional practices. Within 15 years, the study estimated that New York City would pay about \$200,000 less annually to operate the green strategy in comparison to the gray strategy. Over a 20-year period, the Green Strategy is projected to save New York City \$1.5 billion (EPA, 2012). New York City’s Green Strategy is predicted to have higher maintenance and operation costs in the first years of implementation, but they will likely be lower in the long term because they don’t rely on expensive energy inputs such as electricity and natural gas (Roseen et al., 2011).

In 2007, The Environmental Protection Agency conducted cost analyses for 12 different stormwater management projects across the country. The study evaluated the costs associated with LID versus conventional stormwater management in various types of developments. In 11 of the 12 developments, projects guided by LID principles had lower costs than conventional stormwater alternatives. The capital cost savings for implementing LID management principles ranged from 15-80 percent, with one exception where costs of LID were higher than conventional (Environmental Protection Agency, 2007). One of the case studies, Somerset Subdivision in Maryland, featured a development that was built with half LID and half conventional management. The construction and installation cost savings for the LID portion of the site in comparison to the conventionally managed section were \$785,000 (Environmental Protection Agency, 2007).

University of New Hampshire’s Stormwater Center spearheaded a project in 2011 to evaluate the economics of Green Stormwater Infrastructure and Low Impact Development. The result is a report “Forging The Link”, which helps municipalities and communities make economically informed decisions about stormwater management. One of the several case studies referenced in this report was an example of a subdivision project in New Hampshire comparing conventional subdivisions to conservation subdivisions. “In another example, an analysis of 184 lots in one community found that conservation subdivisions were more profitable than conventional

subdivisions. Lots in the conservation subdivisions cost an average of \$7,000 less to produce, resulted in a 50 percent decrease in selling time, and had a value of 12 to 16 percent more as compared to lots in conventional subdivisions” (Mohamed, 2006 as cited in Roseen et. Al., 2011).

The City of Portland, Oregon realized a \$63 million cost benefit to the city by including green stormwater infrastructure strategies in combination with upgrading gray infrastructure for Combined Sewer Overflow mitigation. The City of Kansas City estimates a \$19 million benefit for their incorporation of green infrastructure with existing gray infrastructure (Roseen et al., 2011). While both of these projects were designed to prevent Combined Sewer Overflows, any efforts to direct stormwater away from storm drains will have profound impacts on water quality, regardless of whether the municipality has a combined sewer system or a separate sewer storm system.

In West Union, Iowa, the Iowa Economic Development office conducted a cost-benefit analysis of permeable pavement, as part of a larger low impact development integration community revitalization effort. The analysis focused on comparing the costs of replacing asphalt with permeable pavement. The analysis found that although the start-up costs for permeable pavement were higher, the lower maintenance and repair costs will ultimately result in cost savings in the long run. The city is estimated to realize the cost savings by year 15 of the project. Over a 57 year period, the total estimated savings are estimated to amount to about \$2.5 million (U.S. EPA, 2013). There were also multiple benefits of GSI that West Union did not quantify, such as improved water quality, increased stream health and appearance, reduced storm sewer infrastructure and maintenance, improved pavement surface temperatures, and improved street appearance.

A 2005 study compared the value of urban trees in five different towns in the Southwestern and Northwestern U.S. Although these cities spent \$13 to 65 annually per tree, benefits ranged from \$31 to \$89 per tree. For every dollar invested in management, benefits returned annually ranged from \$1.37 to \$3.09 (Mcpherson, Simpson, Peper, Maco, & Xiao, 2005). For the benefits in stormwater reduction alone, the City of Bismarck, North Dakota gains \$28/tree, which composes over half of the cost benefit that the municipality gains from urban trees. The monetary benefits were based on an ecosystem service valuation process, where the authors estimated energy savings caused by tree shade, atmospheric CO<sub>2</sub> reductions, air quality benefits, stormwater runoff reductions, aesthetics and other benefits, such as sense of place, privacy, and wildlife habitat (Mcpherson et al., 2005).



## CONCLUSION

The Town of Milton must act urgently to avoid significant economic, environmental, and social costs. Stormwater pollution threatens Milton's drinking water supply, public infrastructure, grand list values, and recreation and tourism opportunities. If Milton doesn't build a well-funded stormwater management program, a Milton stream will likely become stormwater impaired, or Milton will become noncompliant with its MS4 Permit, both of which will subject Milton to significant regulatory costs.

Green Stormwater Infrastructure (GSI) and Low Impact Development (LID) are important components of a preventative, cost-effective, long-term strategy to prevent enormous municipal expenses. GSI offers a price-comparable alternative to conventional stormwater management with significantly better pollutant reduction outcomes. Despite concerns about winter weather, GSI systems are able to function throughout winter under most conditions. In comparison to gray infrastructure, GSI practices require lower maintenance costs for each kilogram of phosphorus removed. There are several case studies that demonstrate that GSI and LID systems are less costly than gray infrastructure systems. Due to Milton's sandy soils, Milton is uniquely suited for infiltration practices, which are the most efficient stormwater treatment mechanisms available.

Additionally, GSI systems provide multiple benefits to society beyond stormwater management, such as reducing the urban heat island effect, reducing social vulnerability, recharging groundwater supplies, and increasing property values.

This report contains thirteen recommendations for building a cost-effective long-term strategy for stormwater management. Milton is currently fortunate enough to work in partnership with the Resilient Right of Way team until January, 2018. This is a unique opportunity for Milton to utilize that technical support to build a sustainable stormwater management program. The appendices contain resources for elected officials, town staff, and interested community members to learn more and find tools to support the recommendations outlined in the report.

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## **APPENDICES**

## **A1. CCRPC CLEAN WATER FUNDING 2018**

## Vermont Clean Water Funding Opportunities for Municipalities (SFY2018)

### VERMONT AGENCY OF TRANSPORTATION (VTTrans)

GRANT PROGRAM	DESCRIPTION	FUNDING DETAILS	CONTACT	DUE DATE
Better Roads	Municipal roadway improvements that benefit water quality, including: Inventories of roadway erosion and/or stormwater management issues and capital budget planning (Category A) Correction of road related erosion and/or construction of stormwater management projects (Category B) Correction of streambank and/or slope related problems (Category C) Roadway structures and culvert upgrades (Category D)	Total Funding Available: \$3 million Max. Award: Category A: \$8,000 Category B: \$20,000 Category C: \$40,000 Category D: \$40,000 Match Requirement: 20% local	Better Roads Project Coordinators: Alan May, Eastern Vermont alan.may@vermont.gov   802-828-4585 Linda Blasch, Western Vermont linda.blasch@vermont.gov   802-498-7216 <a href="http://vttrans.vermont.gov/highway/better-roads">http://vttrans.vermont.gov/highway/better-roads</a>	Annually, late Spring
Municipal Highway and Stormwater Mitigation	Environmental mitigation activities, including stormwater and water pollution prevention, management, and control related to highway construction or highway runoff	Total Funding Available: \$5.9 million Max. Award: N/A Match Requirement: 20% local	Joel Perrigo, VTTrans Project Manager joel.perrigo@vermont.gov   802-828-2583	Annually, late Summer
Transportation Alternatives Program	Environmental mitigation activities, including stormwater and water pollution prevention, management, and control related to highway construction or highway runoff	Total Funding Available: \$2.2 million Maximum Award: \$300,000 Match Requirement: 20% for design and construction, 50% for scoping	Scott Robertson, VTTrans Project Manager scott.robertson@vermont.gov   802-828-5799 <a href="http://vttrans.vermont.gov/highway/local-projects/transport-alt">http://vttrans.vermont.gov/highway/local-projects/transport-alt</a>	Annually, Fall



## Vermont Clean Water Funding Opportunities for Municipalities (SFY2018)

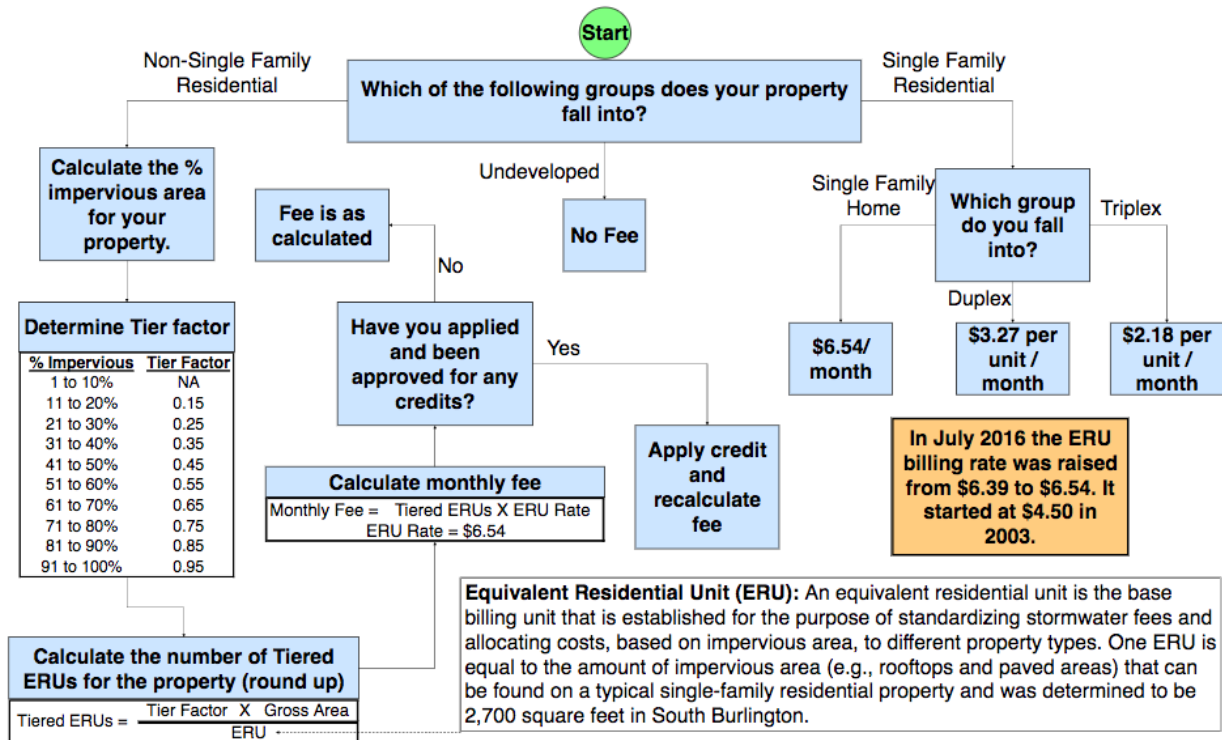
### VERMONT AGENCY OF NATURAL RESOURCES, DEPARTMENT OF ENVIRONMENTAL CONSERVATION (DEC)

GRANT PROGRAM	DESCRIPTION	FUNDING DETAILS	CONTACT	DUE DATE
Municipal Roads Grants-in-Aid Pilot	Road erosion control projects on hydrologically connected road segments currently not meeting draft Municipal Roads General Permit standards	Total Funding Available: \$2.1 million, allocated based on towns' hydrologically connected road miles Match Requirement: 20% local cash/in-kind	Enroll through your local Regional Planning Commission <a href="https://www.vapda.org">https://www.vapda.org</a>	July 5, 2017
Ecosystem Restoration Grants	Design and construction of water pollution abatement and control projects that target nonpoint sources of pollution, including stormwater management, natural resources restoration, road erosion control, and municipal capital equipment projects	Total Funding Available: \$3 million Match Requirement: 50% for MS4 stormwater/road projects Capital equipment projects: 50% for large towns (> 5,000 residents) 20% for small towns (≤ 5,000 residents) Non-MS4/capital equipment projects scored higher based on match provided	Marli Rupe, Clean Water Initiative Program Assistant Manager <a href="mailto:marli.rupe@vermont.gov">marli.rupe@vermont.gov</a>   802-490-6171 <a href="http://dec.vermont.gov/watershed/cwi/grants">http://dec.vermont.gov/watershed/cwi/grants</a>	Rolling applications with quarterly review
Multi-Sector Clean Water Block Grant	Construction of clean water improvement projects, administered by statewide partner(s), including stormwater management and natural resources restoration projects	Total Funding Available: \$1.5 million Match Requirement: 50% for MS4 stormwater/road projects 20% for non-MS4 projects	Multi-Sector Clean Water Block Grant recipients will administer projects under this program Block Grant recipient contacts will be posted here: <a href="http://dec.vermont.gov/watershed/cwi/grants">http://dec.vermont.gov/watershed/cwi/grants</a>	June 6, 2017
Clean Water State Revolving Loan Fund (CWSRF)	Low interest loans/subsidy for municipal/municipally sponsored wastewater treatment upgrade/refurbishment, combined sewer overflow abatement, and stormwater/nonpoint source management projects	Total Financing Available: \$87 million Match Requirement: N/A	Thomas Brown, CWSRF Program Lead <a href="mailto:thomas.brown@vermont.gov">thomas.brown@vermont.gov</a>   802-622-4205 <a href="http://dec.vermont.gov/facilities-engineering/water-financing/cwsrf">http://dec.vermont.gov/facilities-engineering/water-financing/cwsrf</a>	N/A



## A2. SOUTH BURLINGTON STORMWATER UTILITY FEE STRUCTURE

### Process Flowchart For Calculation of Stormwater Utility Fee



Disclaimer: Utility rates have increased since this flowchart was last updated.

Credit calculation illustrated below. This structure incentivizes property owners to implement stormwater control measures by deducting credit percentage from stormwater fee.

Treatment Standard or Criteria	Credit Amount
Water Quality (WQ <sub>v</sub> )	15%
Groundwater Recharge (Re <sub>v</sub> )	15%
Channel Protection (CP <sub>v</sub> )	15%
Overbank Flood (Q <sub>p10</sub> ) or Extreme Storm (Q <sub>p100</sub> )	10%
Non-structural practices	10%



### **A3. BURLINGTON EROSION PREVENTION AND SEDIMENT CONTROL FORMS**



**Burlington Department of Public Works**  
**Stormwater Program**  
645 Pine Street  
Burlington, VT 05401  
PH: 802-540-1748 Email: [mmoir@ci.burlington.vt.us](mailto:mmoir@ci.burlington.vt.us)



### Small Project Erosion Prevention & Sediment Control Plan

This questionnaire, at a minimum, is required to accompany all zoning or building permit applications **which involve 400 sq. ft. or more of land disturbance**. Please also provide a site plan indicating the locations of all erosion prevention and sediment control measures (silt fence, hay bales etc).

Properties with greater than 2500 sq. ft. of total impervious surfaces, that are adding more impervious, will also be required to comply with additional long term stormwater management requirements.

1. Project Location \_\_\_\_\_
2. Brief Project Description (i.e. house foundation, swimming pool)  
\_\_\_\_\_  
\_\_\_\_\_
3. Owner Name: \_\_\_\_\_
4. Owner Mailing Address: \_\_\_\_\_
5. Owner Phone: \_\_\_\_\_ 6. Owner email: \_\_\_\_\_
7. Contractor Name: \_\_\_\_\_
8. Contractor Phone: \_\_\_\_\_ 9. Contractor Email: \_\_\_\_\_
10. Estimated Project Start Date \_\_\_\_\_ Estimated End Date \_\_\_\_\_
11. Area of Land Disturbance \_\_\_\_\_ sq. ft.
12. Total proposed (existing + new) amount of impervious: \_\_\_\_\_ sq. ft.
13. Estimated distance in feet from disturbance to nearest:
  - a. City Sidewalk or Street \_\_\_\_\_ ft
  - b. Drainage Ditch \_\_\_\_\_ ft
  - c. Catch Basin (storm drain) \_\_\_\_\_ ft
  - d. Lake/River/Stream \_\_\_\_\_ ft
14. Site plan/sketch **MUST BE ATTACHED** showing the following:
  - ☐ Limits of disturbance
  - ☐ Direction of stormwater flow on site
  - ☐ Location of stockpiles (if any)
  - ☐ Location of sediment control BMP's (silt fence etc.)

#### **EPSC QUESTIONNAIRE (See last page for typical solutions to these questions)**

A) Nature of all site disturbances (check all that apply):

- ☐ Underground utility trench(es)   ☐ curb cut/driveway   ☐ foundation   ☐ cut/fill/regrading   ☐ landscaping  
☐ other \_\_\_\_\_

B) Do you anticipate the need for any dewatering of excavations during the construction? ☐ Yes   ☐ No

- If yes, how will the pumped water be managed or filtered to prevent the discharge of dirty water?

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\*impervious = any surface off of which water runs off rather than infiltrates, including, but not limited to rooftops and paved/unpaved (gravel/packed dirt) driveways, walkways and patios

Sept 2012 (ver. 4)

C) Will excavated soil be stockpiled on the site? ☐ Yes ☐ No

- If yes, how long will the stockpile be on site? (i.e. 1 day, 1 week) \_\_\_\_\_

How do you propose to control erosion of the stockpile? \_\_\_\_\_

- If no, where is the ultimate disposal of excess soil? \_\_\_\_\_

D) How do you propose to prevent sediment from leaving the site and entering nearby city sidewalks/streets and storm drains and/or lakes, rivers and streams? (see page 4 for examples)

\_\_\_\_\_

\_\_\_\_\_

E) Do you plan to park construction vehicles on or disturb City owned property like the greenbelt area? ☐ Yes ☐ No

- If yes, tell us how you agree to repair all disturbances or damage to City owned property and provide a written approval from the City allowing construction vehicles to park on City owned property.

\_\_\_\_\_

\_\_\_\_\_

- If no, then please monitor all construction and visitor vehicles and advise all not to park on City owned property.

F) How do you propose to either prevent or clean sediment generated from construction vehicles and activities that becomes deposited on City streets, sidewalks, or bikepaths and how frequently this will be done.

\_\_\_\_\_

\_\_\_\_\_

G) Will stockpiles or disturbed soils be present and/or exposed after Nov. 1<sup>st</sup> of any construction year? ☐ Yes ☐ No

- If yes, tell us how you plan to stabilize any stockpile and/or disturbed soils.

\_\_\_\_\_

\_\_\_\_\_

**Do you agree to abide by the following conditions?**

☐ Y ☐ N Applicant will call 540-1748 or email [mmois@burlingtonvt.us](mailto:mmois@burlingtonvt.us) at least 24 hours prior to initiating earth disturbance and submit the **name and contact (cell phone and email) of the erosion control coordinator for the project**

☐ Y ☐ N Applicant will post the notice in a visible location

☐ Y ☐ N I acknowledge that it is the responsibility of the owner and his/her representatives to ensure that:

- sediment does not enter surface water bodies (streams, ditches, ponds, lakes, wetlands etc.)
- sediment does not enter City conveyance infrastructure (catch basins, sewers etc.) and
- All sediment must be removed from the city ROW (sidewalks and roadways) by the end of each work day.

☐ Y ☐ N Sediment control measures will be installed prior to the initiation of earth disturbance.

☐ Y ☐ N During the non-winter construction season (April 15 – November 1): After an initial **14 day** period of initial disturbance, temporary or permanent stabilization (mulching, erosion control matting or tarps for stockpiles, or other approved method) of exposed areas and stockpiles will occur at the end of each work day unless:

- Earthwork is to continue in the area within the next 24 hours **and** there is NO liquid precipitation forecast for the next 24 hours; or
- If work is occurring in a self contained excavation (no outlet) with a depth of 2 feet or greater (e.g. house foundation excavation or utility trenches).

Sept 2012(ver.4)

- ☐Y ☐N During the winter construction period from November 1 to April 15, any **new disturbance** must be temporarily or permanently stabilized (mulching, erosion control matting or tarps for stockpiles, or other approved method) will occur at the end of each work day unless:
- Earthwork is to continue in the area within the next 24 hours **and** there is NO liquid precipitation forecast for the next 24 hours; or
  - If work is occurring in a self-contained excavation (no outlet) with a depth of 2 feet or greater (e.g. house foundation excavation or utility trenches)
- ☐Y ☐N The perimeter of the site and all BMPs will be inspected at the **end of each workday** to ensure that sediment will not leave the site. If sediment has travelled beyond the site boundary, it shall be swept up or otherwise removed and deposited on-site in an upgradient area at the **end of each work day**.
- ☐Y ☐N The owner and his/her representatives shall abide by the best management practices (BMPs) indicated in this plan and conditions and in the Vermont DEC Low Risk Site Handbook for Erosion Prevention and Sediment Control (2006). Contact 802-540-1748 for a hard copy or go to the web:  
[http://vtwaterquality.org/stormwater/docs/construction/sw\\_low\\_risk\\_site\\_handbook.pdf](http://vtwaterquality.org/stormwater/docs/construction/sw_low_risk_site_handbook.pdf)
- ☐Y ☐N **If soils will be exposed after November 1st and winter construction has not been permitted the project will notify DPW prior to October 15th.** If the project is completed during the winter months, an additional inspection will be required to ensure that the site is buttoned up for the winter.
- ☐Y ☐N Within 48 hours of reaching final grading, the exposed soil will be seeded and mulched or covered with erosion control matting (for slopes steeper than 3:1 or high wind prone areas). Erosion control matting is preferred.
- ☐Y ☐N The owner will contact DPW to schedule a stabilization inspection when site work is finished and stabilization measures (seeding and mulching or matting) have been installed.

#### **AGREEMENT**

By filling out and signing this plan, I agree to abide by the terms and conditions outlined above. Failure to follow this plan can result in a stop work order by the City of Burlington, fines, or both.

By: ☐ Owner    ☐ Contractor    ☐ Architect/Engineer

Name	Signature	Date

Additional Conditions of Approval:

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#### Required Compliance Items:

- Notification of start/identification of EPSC responsible party
- Winter Stabilization Inspection (if applicable)
- Final Stabilization

# **AN EROSION PREVENTION AND SEDIMENT CONTROL PLAN**

**FOR THE PROJECT AT:**

---

**HAS BEEN FILED WITH THE CITY OF BURLINGTON  
STORMWATER MANAGEMENT PROGRAM IN ACCORDANCE  
WITH CHAPTER 26 OF THE BURLINGTON CODE OF ORDINANCES**

**THIS REQUIRES THAT MEASURES BE INSTALLED OR TAKEN TO  
PREVENT SEDIMENT FROM LEAVING THE SITE AND ENTERING  
WATERWAYS AND IMPACTING CITY INFRASTRUCTURE  
(RIGHT OF WAY AND STORMDRAINS)**

**FOR QUESTIONS OR TO REPORT SEDIMENT LEAVING THE SITE  
CALL 802-540-1748**

**This notice to be posted in full view at all times during earth  
disturbance. Additional conditions on attached.**

Plan Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
Megan J. Moir, CPESC, CPSWQ

Sept 2012(ver.4)



## TYPICAL SOLUTIONS TO PREVENT OR CONTROL SEDIMENT AND EROSION

### STOCKPILES

- Cover small stockpiles with a tarp when not being used.
- Install silt fencing or other appropriate devices around the stockpiles to filter sediment.
- Cover stockpiles with straw or other approved mulching material.
- Plan to remove any unusable material as soon as possible from the site to an approved location.
- Plant grass and mulch stockpiles that will be on site for more than 14 days.
- Cover, vegetate or install erosion matting on stockpiles that will remain disturbed over the winter.

### DISTURBED AREAS

- Maintain vegetated buffers around disturbed areas.
- Install silt fencing or other appropriate device to filter sediment washing off from disturbed areas. Remember that the bottom of the silt fence must be “keyed in” (dug into ground) to work correctly.
- To prevent sediment from running off your site via your driveway (or other paved areas where you can’t install silt fence) use a row of hay bales or tube sand.
- Cover disturbed areas as soon as possible with straw or other approved mulching material. Use erosion control matting in high wind, traffic or slopes steeper than 3:1 (horizontal to vertical), and follow the manufacturer’s guidelines staple the matting down.
- Plant grass and mulch or use erosion control matting all disturbed areas that will remain exposed for more than 14 days.
- Cover, vegetate or install erosion matting on areas that will remain disturbed over the winter.
- Protect ditches, catch basins or water bodies off-site by using silt fencing, gravel check dams or other approved sediment control methods.

### CONSTRUCTION VEHICLES

- Do not park construction vehicles on City owned green space. Vehicles disturb vegetation and compact the soil, thereby reducing its ability to infiltrate stormwater. Any green belt disturbance will need to be permanently stabilized with grass seed and erosion control matting.
- Prevent sediment from leaving the project by cleaning the tires of vehicles, or use clean gravel at project access points to clean tires.
- Sweep city streets, sidewalks and bikepaths daily or as needed to remove sediment transported from the project.

### RESOURCES

The Vermont Handbook for Erosion Prevention and Sediment Control at:

[http://vtwaterquality.org/stormwater/docs/construction/sw\\_low\\_risk\\_site\\_handbook.pdf](http://vtwaterquality.org/stormwater/docs/construction/sw_low_risk_site_handbook.pdf)

The City of Burlington Stormwater Program Page at

<http://www.dpw.ci.burlington.vt.us/stormwater/>



















The City of Burlington Conservation Board Stormwater and Erosion Control Fact sheet at

<http://www.ci.burlington.vt.us/planning/cb/stormwater/management.html>

## A4. CENTER FOR NEIGHBORHOOD TECHNOLOGY: TABLE OF BENEFITS FROM GSI

### Green Infrastructure Benefits and Practices

This section, while not providing a comprehensive list of green infrastructure practices, describes the five GI practices that are the focus of this guide and examines the breadth of benefits this type of infrastructure can offer. The following matrix is an illustrative summary of how these practices can produce different combinations of benefits. Please note that these benefits accrue at varying scales according to local factors such as climate and population.

Practice	Benefit	
	Reduces Stormwater Runoff	Improves Community Livability
Green Roofs	 Reduces Water Treatment Needs	 Improves Water Quality
	 Reduces Grey Infrastructure Needs	
	 Reduces Flooding	
	 Increases Available Water Supply	
Tree Planting	 Increases Groundwater Recharge	 Reduces Salt Use
	 Reduces Energy Use	
	 Improves Air Quality	
	 Reduces Atmospheric CO <sub>2</sub>	
Bioretention & Infiltration	 Reduces Urban Heat Island	 Improves Aesthetics
	 Increases Recreational Opportunity	
	 Reduces Noise Pollution	
	 Improves Community Cohesion	
Permeable Pavement	 Urban Agriculture	 Improves Habitat
	 Cultivates Public Education Opportunities	
Water Harvesting		

☒ Yes
 ☐ Maybe
 ☐ No

## **A5. COMPARING MAINTENANCE COSTS OF GSI AND GRAY INFRASTRUCTURE**



# Comparison of Maintenance Cost, Labor Demands, and System Performance for LID and Conventional Stormwater Management

James J. Houle<sup>1</sup>; Robert M. Roseen, Ph.D., P.E., D.WRE, M.ASCE<sup>2</sup>;  
Thomas P. Ballesterio, Ph.D., P.E., M.ASCE<sup>3</sup>; Timothy A. Puls<sup>4</sup>; and James Sherrard Jr.<sup>5</sup>

**Abstract:** The perception of the maintenance demands of low impact development (LID) systems represents a significant barrier to the acceptance of LID technologies. Despite the increasing use of LID over the past two decades, stormwater managers still have minimal documentation in regard to the frequency, intensity, and costs associated with LID operations and maintenance. Due to increasing requirements for more effective treatment of runoff and the proliferation of total maximum daily load (TMDL) requirements, there is a greater need for more documented maintenance information for planning and implementation of stormwater control measures (SCMs). This study examined seven different types of SCMs for the first 2–4 years of operations and studied maintenance demands in the context of personnel hours, costs, and system pollutant removal. The systems were located at a field facility designed to distribute stormwater in parallel in order to normalize watershed characteristics including pollutant loading, sizing, and rainfall. System maintenance demand was tracked for each system and included materials, labor, activities, maintenance type, and complexity. Annualized maintenance costs ranged from \$2,280/ha/year for a vegetated swale to \$7,830/ha/year for a wet pond. In terms of mass pollutant load reductions, marginal maintenance costs ranged from \$4–\$8/kg/year TSS removed for porous asphalt, a vegetated swale, bioretention, and a subsurface gravel wetland, to \$11–\$21/kg/year TSS removed for a wet pond, a dry pond, and a sand filter system. When nutrients such as nitrogen and phosphorus were considered, maintenance costs per gper year removed ranged from reasonable to cost-prohibitive, especially for systems with minimal to no nutrient removal. As such, SCMs designed for targeting these pollutants should be selected carefully. The results of this study indicate that generally, LID systems, as compared to conventional systems, have lower marginal maintenance burdens (as measured by cost and personnel hours) and higher water quality treatment capabilities as a function of pollutant removal performance. Cumulative amortized system maintenance expenditures equal the SCM capital construction costs (in constant dollars) in 5.2 years for wet ponds and in 24.6 years for the porous asphalt system. In general, SCMs with higher percentages of periodic and predictive or proactive maintenance activities have lower maintenance burdens than SCMs with incidences of reactive maintenance. DOI: 10.1061/(ASCE)EE.1943-7870.0000698. © 2013 American Society of Civil Engineers.

**CE Database subject headings:** Best Management Practice; Maintenance; Costs; Stormwater management; Water quality.

**Author keywords:** BMP; Maintenance; Cost; LID; Operation; Stormwater; Labor; Water quality; Expenses.

## Introduction

The misunderstanding of inspection and maintenance expectations for low impact development (LID) systems has been one of the significant barriers to the acceptance of LID technologies. Most entities

in charge of stormwater management systems over the past four decades generally have adopted maintenance plans or guidelines for conventional systems (curb, gutter, swale, and pond), yet there is little documentation in terms of the frequency, intensity, and costs associated with LID maintenance operations required to meet system design objectives. With increasing requirements for more efficient stormwater management designs and the proliferation of total maximum daily load (TMDL) requirements, a greater amount of documented maintenance information is necessary to facilitate the implementation of more effective stormwater management strategies. Increased attention to pollutant loads, numeric goals, and nondegradation requirements have also created the need for more emphasis on stormwater control measure (SCM) maintenance in order to meet permitting and reporting requirements (Erickson et al. 2010). Furthermore, as municipalities move to implement LID, managers need better information, resources, and methods to estimate an LID techniques' total costs, including maintenance. With more long-term LID maintenance costs available, cost estimations of this alternative will become easier to accomplish and more precise (Powell et al. 2005).

Traditionally, there has been significant resistance toward the acceptance and adoption of LID designs due to the perception that these systems have substantial maintenance requirements,

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representing a significant cost burden to developers and site owners. In contrast, proponents regard LID designs as lower in maintenance compared to conventional stormwater controls [MacMullan and Reich 2007; Powell et al. 2005; U.S. Environmental Protection Agency (EPA) 2000].

As an example of the available documentation directing LID maintenance protocols, the Prince George's County Department of Environmental Resources (PGDER) bioretention manual (2007) recommends a frequency and time of year for the maintenance of plants, soil, and the organic layer of bioretention systems. Likewise, the Washington State University (WSU) Pierce County Extension report, "Maintenance of low impact development facilities," (WSU Pierce County Extension 2007) provides maintenance schedules for bioretention and permeable paving areas, listing general maintenance activity recommendations, including objectives. However, while recommending specific activities and frequencies associated with LID maintenance, these documents, like others, do not cover costs and are not based on empirical data or referable evidence in terms of studied LID maintenance activities for ensuring system functionality. While many stormwater management manuals have stated the importance and estimated frequency of maintenance for SCMs, few have documented the actual frequency and intensity of maintenance required to maintain a desired level of performance and efficiency (Erickson et al. 2010).

Weiss et al. (2005), in a study comparing the cost and effectiveness of several common SCMs including LID designs (constructed wetlands, infiltration trenches, sand filters, bioinfiltration filters), found little data available that documented actual operation and maintenance (O&M) costs of existing SCMs. At best, the study found that available data consisted only of expected or predicted O&M costs of recently constructed SCM projects. Often, estimated annual O&M costs are presented as a percentage of the total capital cost (Weiss et al. 2005) or as an annual percentage of capital costs (Narayanan and Pitt 2006). An example includes the EPA's (1999) annual O&M costs for a range of typical SCMs, expressed as a percentage of the construction cost.

In a study for advancing short- and long-term maintenance considerations so as to develop more realistic maintenance plans, Erickson et al. (2010) conducted a detailed municipal public works survey to identify and inventory stormwater SCM O&M efforts and costs. Results indicated that most cities (89%) perform routine maintenance once per year or less, with staff-hours per year ranging from 1 to 4 h for most stormwater SCMs but significantly higher for rain gardens (1 to 16 h per year) and wetlands (1 to 9 h per year). In terms of costs, the study found that SCM maintenance expenses will roughly equal the construction cost (in constant dollars) after 10 years for a \$10,000 installation (i.e., 10% of capital cost) and after 20 years for a \$100,000 installation (i.e., 5% of capital cost in 2005 dollars).

In another effort toward better forecasting life-cycle project cost estimates of different stormwater control alternatives, Narayanan and Pitt (2006) utilized maintenance cost data from the Southeastern Wisconsin Regional Planning Commission (SWRPC), which documented maintenance costs for a range of SCMs, including LID. According to SWRPC figures, incremental average annual maintenance costs in 1989 dollars (over conventional pavement) for a permeable pavement parking lot was found to be \$42/ha (\$17/acre) for vacuum cleaning, \$20/ha (\$8/acre) for high-pressure jet hosing (which should likely only be used in isolated clogged areas), and \$25 per inspection. Likewise, annual SWRPC maintenance costs for infiltration trenches was found to be \$92/ha (\$37/acre) for buffer strip mowing, \$9,690/ha (\$3,920/acre) for general buffer strip lawn care, and \$25 per inspection plus \$50 per trench for program administration.

The objective of this study is to develop quantified maintenance expenditures in the form of required personnel hours and economic costs expended for a broad range of SCMs. The University of New Hampshire Stormwater Center (UNHSC) has tested over 26 treatment strategies to date, logging all inspection hours and maintenance activities over the course of a 6-year study (2004–2010). For the purposes of this study, researchers compiled data from UNHSC testing efforts of seven different types of SCMs including conventional systems such as a wet pond, a dry pond, and a swale, as well as LID systems including bioretention, sand filter, subsurface gravel wetland, and a porous asphalt pavement. Manufactured treatment devices were omitted from this study as many vendors and product providers offer comprehensive and detailed O&M information pertaining to their systems.

## Methodology

### Site Design

The UNHSC site was designed to function as a series of uniformly sized, isolated, and parallel treatment systems with capacity for stormwater to be conveyed to each treatment device without significant transmission impacts from the distribution systems upon processes such as sedimentation. The watershed is a 4.5-ha commuter parking lot. Rainfall-runoff is evenly divided at the headworks of the facility in a distribution box, designed with an elevated floor that is slightly higher than the outlet invert which allows for scouring across the floor and into the pipe network. Effluent from all of the treatment systems flows into a sampling gallery where system sampling and flow monitoring are centralized. The parallel configuration normalizes the treatment processes for event and watershed-loading variations (all technologies receive the same influent hydrograph and water quality). This process and SCM design information are fully described in previous publications (Roseen et al. 2009), and in Table 1.

The SCMs discussed in this paper include a vegetated swale, a wet pond, a dry pond, a sand filter, a subsurface gravel wetland, three bioretention systems (averaged), and a porous asphalt pavement. The treatment strategies are all uniformly sized to treat the same water quality flows and volumes, with equal capacity for conveying large flows. Design criteria were based on a rainfall frequency analysis to determine the 24-h rainfall depth corresponding to a nonexceedance frequency of approximately 90%. For much of the northeast United States, 90% of the daily precipitation ranges from 2.0 to 3.3 cm (0.78 to 1.3 in.) in depth. The 90% criterion was selected by UNHSC researchers during site design for its increasingly widespread usage, ability to generate economical sizing, and because water quality treatment with this guideline accounts for more than 90% of the of the daily precipitation frequency. For Durham, New Hampshire, 2.5 cm (1 in.) or less rainfall depth in one day occurs 92% of the time on the days in which measurable precipitation occurs. These data were derived from a NOAA precipitation gauge with 76 years of records that is within 1 km (0.62 mi) of the site.

### Tracking and Calculation of Maintenance Costs

Stormwater treatment system designs and selection were primarily based on manuals from New York [New York State Department of Environmental Conservation (NYSDEC) 2003], New Hampshire [New Hampshire Department of Environmental Services (NHDES) 1996], and the Federal Highway Administration (Brown et al. 1996; FHWA 2002). The New York State manual includes operation, maintenance, and management inspection checklists for



**Table 1.** UNHSC SCM Design Data (SI Units)

Parameter	Vegetated swale <sup>a</sup>	Wet pond <sup>a</sup>	Dry pond <sup>a</sup>	Sand filter	Gravel wetland	Bioretention #1	Bioretention #2 & #3	Porous asphalt
Device class	Conventional	Conventional	Conventional	LID	LID	LID	LID	LID
Filter length (m)	85.3	21.3	21.3	6.1	15.8	20.4	10.4	26.8
Width (m)	3.0	14.0	14.0	2.4	11.3	10.7	2.4	19.5
Area (m <sup>2</sup> )	260	299	299	15	179	218	25	523
Depth (ft)	0.0	0.5	0.0	0.6	0.6	1.1	0.8	1.3
Ponding depth (ft)	0.6	0.5	0.9	1.5	0.4	0.2	0.2	0.0
Catchment area (ha)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.05
Water quality volume (m <sup>3</sup> )	97.7	97.7	97.7	97.7	97.7	97.7	97.7	13.3
Water quality flow (m <sup>3</sup> /s)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	N/A
Watershed area/filter area	N/A	N/A	N/A	272	22.6	18.6	160	1.00
HLR (m/s)	N/A	N/A	N/A	6.57	14.2	0.45	3.86	N/A

<sup>a</sup>HLR and FA/WA ratios are not calculated for nonfiltration systems.

several SCMs. The manual guidelines were utilized on a monthly basis to track observations and maintenance activities for all SCMs discussed in this paper except for the porous asphalt system. The routine use of these forms helped to establish a framework for development of annual maintenance strategies. The porous asphalt maintenance activities were developed by adjusting typical maintenance activities for standard asphalt surfaces and applying them to porous systems. Maintenance tracking consisted of initial observations using inspection checklists, written documentation in field books, photo documentation of issues, and research staff assessments. Maintenance activity documentation included SCM name, activity description, labor hours to complete task, materials, and name of staff members involved. Annual maintenance strategies were evaluated by quantifying hours spent, assessing difficulty of activities, and applying a standard cost structure. To better illustrate costs and anticipate maintenance burdens, activities were characterized into distinct categories. First, activities were assigned a maintenance complexity according to published criteria (Erickson et al. 2010). Second, a unit conversion with relative estimated hourly expenses according to each complexity category was added. This can easily be adapted according to local conditions, current economic climate, and regional cost variations; however scaled differences would likely produce similar unitless ratios.

- Minimal—\$75/h—stormwater professional or consultant is seldom needed.
- Simple—\$95/h—stormwater professional or consultant is occasionally needed.
- Moderate—\$115/h—stormwater professional or consultant is needed approximately half the time.
- Complicated—\$135/h—stormwater professional or consultant is always needed.

These categories allow more accurate cost predictions and provide insight into the appropriate assignment of maintenance responsibilities. Minimal complexity activities can generally be performed by nonprofessionals and may include tasks such as mowing or slope seeding, whereas complicated activities may necessitate a design specification or the use of heavy equipment for requirements such as algae removal from a wet pond.

Secondly, activities were categorized with respect to a maintenance approach. The four basic maintenance approaches are found below (adapted from Debo and Reese 2002):

- Reactive—complaint or emergency driven.
- Periodic and predictive—driven by inspections and standards embodied in an O&M plan; can be calendar-driven, known, or schedulable activities.
- Proactive—adaptive and applied increasingly more as familiarity with the system develops.

## Results and Discussion

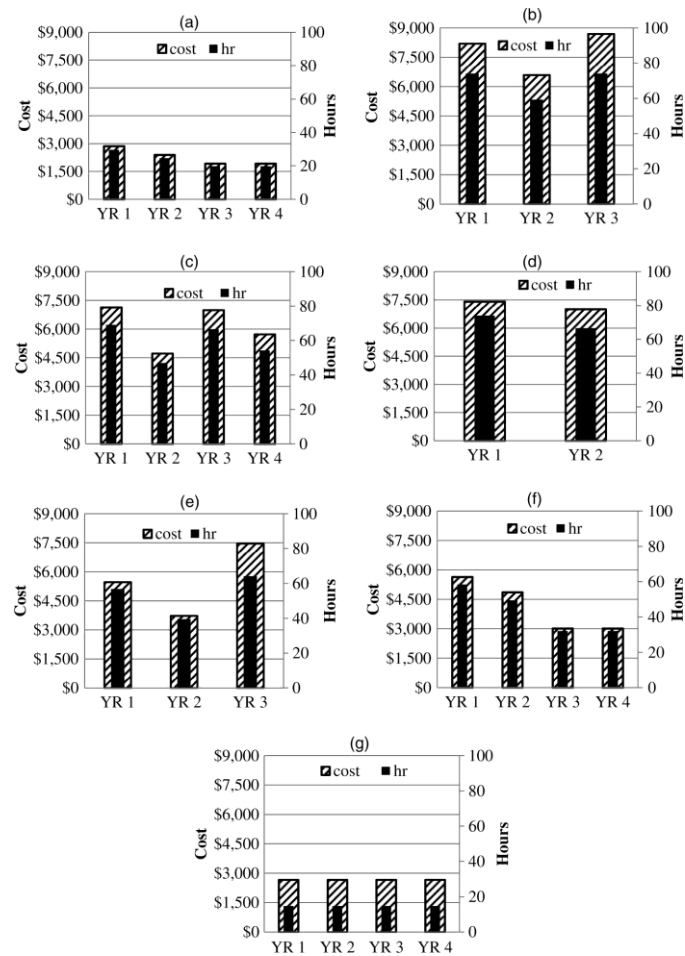
Maintenance of stormwater management facilities is essential for ensuring that systems perform properly. This analysis relies on the assumption that routine maintenance and inspections of SCMs are performed as recommended. The development of an effective maintenance program takes time, and as with most systems, it is not only specific to the individual SCM but with many other variables including the overall design, system sizing, location, land use, and other watershed characteristics. In most cases, maintenance approaches are not static but are instead adaptive as maintenance staff become familiar with the systems and are better able to plan for maintenance activities.

These research results indicate that maintenance activities are progressive: maintenance tasks often start out as reactive (the most expensive category of maintenance) but subsequently evolve into periodic and proactive approaches. Figs. 1(a–g) illustrates annual maintenance costs and personnel hours expended for each of the studied SCMs over time. Our research indicates that if maintenance activities are simple, then periodic and routine maintenance costs are kept at a minimum. Fig. 2 illustrates that SCMs with higher percentages of periodic and predictive or proactive maintenance activities have lower maintenance burdens than SCMs with incidences of reactive maintenance.

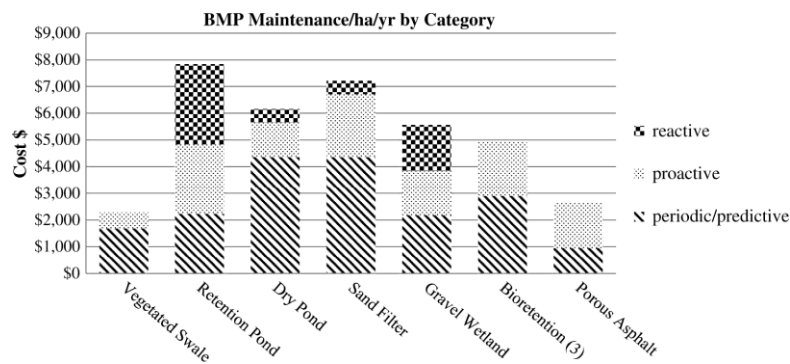
As depicted in Figs. 1 and 2 and Table 2, maintenance burdens for vegetated filtration systems were generally less with respect to cost and personnel hours, compared to conventional SCMs such as ponds, with vegetated swales and sand filters as the exceptions. However, these results should be considered as conservative in that they document the most expensive period of maintenance that might be anticipated (the start-up years). Barring unexpected maintenance issues or severe weather events that could occur beyond this study's time frame, the maintenance activities, approaches, and expenditures examined in this study generally became less intensive and diminished over time as maintenance familiarity increased [Figs. 1(a and f)]. As an example, maintenance with respect to vegetated systems was found to require more attention during the first months and years of vegetation establishment. Additionally, while the activities associated with maintaining LID practices were found to be less expensive and more predictable than conventional systems, the scale, location, and nature of LID system maintenance requires different equipment (rakes and wheel barrels as opposed to tractor trucks) and will require new maintenance standards and strategies.

## Staff Hours

Personnel hours dedicated to maintenance for the SCMs included in this study are displayed in Table 2. As shown, average annual



**Fig. 1.** Annual maintenance costs and personnel hours tracked per system per ha of IC treated per year: (a) vegetated swale; (b) wet pond; (c) detention pond; (d) sand filter; (e) gravel wetland; (f) bioretention; (g) porous asphalt



**Fig. 2.** Annualized maintenance costs per system per hectare of IC treated per maintenance activity classification



staff-hours per SCM ranged from 14.8 to 70.4 h per hectare of impervious cover (IC) treated per year (6 to 28.5 h/acre/year). The sand filter system was found to require the most staff-hours, followed in declining sequence by the wet pond, dry pond, subsurface gravel wetland, bioretention, vegetated swale, and finally, the porous asphalt pavement. These results were surprising as many of the conventional systems such as wet and dry ponds were found to carry the largest maintenance burdens. Maintenance routines for these systems required more tasks and included more reactive activities such as algae removal and outlet cleaning which tend to be more complex and incur higher costs. Also interesting to note is that, although porous asphalt pavement is generally perceived as cost prohibitive because of high anticipated maintenance burdens, the porous asphalt system in this study was actually found to have the lowest maintenance burden overall in terms of personnel hours and the second lowest annual costs. Pavement vacuuming, which makes up the bulk of the costs associated with porous asphalt maintenance, is a service that is increasingly available in the private sector. This fact, in combination with the small number of maintenance tasks, all ranging toward predictive and proactive activities (inspection and proactive sweeping), keeps overall maintenance burdens low.

### Marginal Costs

Marginal costs for maintenance activities associated with total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN) removal were converted to annualized costs per system per watershed area treated (Table 2) and annualized costs per system per mass of pollutant removed (Table 3). Because TN removal efficiencies were not calculable for every SCM tested, dissolved inorganic nitrogen ( $\text{NO}_3$ ,  $\text{NO}_2$ ,  $\text{NH}_4$ ) was used instead. Capital costs for SCMs are presented in terms of dollars per hectare of IC treated (real and constant dollars), and maintenance expenditures are presented as an annualized percentage of capital costs, a measure routinely used for projected SCM cost estimates.

Fig. 1 illustrates costs associated with maintenance over the years of study per hectare of IC treated. Some systems, such as the wet pond and the subsurface gravel wetland [Figs. 1(b and e)], displayed cycling maintenance costs over the course of the study, while others, such as the vegetated swale, bioretention, and porous asphalt systems [Figs. 1(a, f and g)], reached a steady state after the first few years of operation. Annualized data are summarized in Table 2 and Fig. 2. In the majority of cases, costs and personnel hours for LID systems were lower per mass of pollutant removed as compared to conventional systems. While the vegetated swale is the least costly system in terms of maintenance, it is also the least effective in terms of annual pollutant load reductions. These data indicate that marginal costs and marginal pollutant load reductions

for LID systems are less costly and require less effort to maintain but still achieve greater pollutant load reductions. Exceptions occur with respect to any LID or conventional SCM that does not have unit operations and processes that effectively target nutrients. SCM maintenance burdens, in some systems such as the sand filter, may be controlled by reducing the hydraulic loading rate (HLR) and/or the watershed area-to-filter area ratio (WA/FA). The HLR is expressed as the ratio of the water quality flow, in cubic meters per second, divided by the surface area of the filter in square meters and expressed in meters per second. The WA/FA ratio is calculated by dividing the watershed area by the filter area, both in square meters, and is expressed as a number or ratio. Both metrics are summarized for each system studied in Table 1. The porous asphalt pavement has the lowest WA/FA of 1.00 and one of the lowest maintenance costs. Alternatively, the sand filter has the second highest WA/FA of 272 and HLR of 6.57 m/s and one of the highest maintenance costs. The subsurface gravel wetland is the exception and illustrates limitations with these metrics for horizontal flow filters and systems throttled by orifice control rather than filter media permeability. These data indicate that adjustments to HLR and/or WA/FA for vertical filtration SCMs can lead to reductions in maintenance burdens, with commensurate decreases in costs per mass of pollutant removed. However, in cases where costs per mass of pollutant trend toward unrealistic levels, alternative systems or treatment train approaches should be adopted as primary water quality management measures.

### Maintenance as a Percentage of Capital Cost

Maintenance costs are a substantial portion of the life-cycle costs of stormwater management practices. Estimates can vary, and there may or may not be economies of scale for larger systems. As illustrated in Table 2, annual maintenance expenses as a percentage of capital costs ranged from 4% to 19%. To calculate these values, all original capital construction costs were converted to constant 2012 dollars using consumer price index inflation rates [U.S. Department of Labor (USDOL) 2012] and are presented in Table 2. The amortized maintenance costs for the wet pond equaled total capital construction costs after only 5.2 years. LID systems, with the exception of the sand filter, had higher capital costs but lower annual maintenance costs compared to the conventional pond systems. As shown in Table 2, the lowest SCM annualized maintenance costs expressed as a percentage of capital costs were porous asphalt (4%), followed by the vegetated swale (6%), the subsurface gravel wetland (8%), and the bioretention systems (8%). At these rates, annual LID system maintenance expenditures will equal total upfront capital costs after 24.6 years for the porous asphalt system, 15.9 years for the vegetated swale, 12.2 years

**Table 2.** UNHSC SCM Installation and Maintenance Cost Data, with Normalization per Hectare of IC Treated

Parameter	Vegetated swale	Wet pond	Dry pond	Sand filter	Gravel wetland	Bioretention	Porous asphalt
Original capital cost (\$)	29,700	33,400	33,400	30,900	55,600	53,300	53,900
Inflated 2012 capital cost (\$)	36,200	40,700	40,700	37,700	67,800	63,200	65,700
Maintenance-capital cost comparison (year) <sup>a</sup>	15.9	5.2	6.6	5.2	12.2	12.8	24.6
Personnel (h/year)	23.5	69.2	59.3	70.4	53.6	51.1	14.8
Personnel (\$/year)	2,030	7,560	5,880	6,940	5,280	4,670	939
Materials (\$/year)	247	272	272	272	272	272	0
Subcontractor Cost (\$/year)	0	0	0	0	0	0	1,730
Annual O&M Cost (\$/year)	2,280	7,830	6,150	7,210	5,550	4,940	2,670
Annual maintenance/capital cost (%)	6	19	15	19	8	8	4

Note: Calculations based on original data with BGS units of \$/acre and h/acre.

<sup>a</sup>Number of years at which amortized maintenance costs equal capital construction costs.



**Table 3.** Summary of Removal Performance and Comparison per kg Removed of TSS and per g Removed of TP and TN as DIN

Parameter	Vegetated swale	Wet pond	Dry pond	Sand filter	Gravel wetland	Bioretention	Porous asphalt
Total suspended solids performance—annual load of 689 kg							
Removal efficiency (%) <sup>a</sup>	58	68	79	51	96	92	99
Annual mass removed (kg)	399	468	544	351	662	632	682
Capital cost performance (\$/kg)	91	87	75	107	102	100	96
Operational cost (\$/kg/year)	6	17	11	21	8	8	4
Total phosphorus performance—annual load of 2,950 g <sup>b</sup>							
Removal efficiency (%) <sup>a</sup>	0	0	0	33	58	27	60
Annual mass removed (g)	0	0	0	974	1,700	799	1,770
Capital cost performance (\$/g)	NT	NT	NT	39	40	79	37
Operational cost (\$/g/year)	NT	NT	NT	7	3	6	2
Dissolved inorganic nitrogen as total nitrogen performance—annual load of 26,600 g <sup>b</sup>							
Removal efficiency (%) <sup>a</sup>	0	33	25	0	75	29	0
Annual mass removed (g)	0	8,770	6,640	0	19,900	7,740	0
Capital cost performance (\$/g)	NT	5	6	NT	3	8	NT
Operational cost (\$/g/year)	NT	0.89	0.93	NT	0.28	0.64	NT

Note: NT = No treatment; values are incalculable as lack of SCMPollutant treatment results in infinite costs.

<sup>a</sup>Values from UNHSC et al. 2012.

<sup>b</sup>Denotes change in unit mass from kg to g.

for the subsurface gravel wetland system, and 12.8 years for the bioretention system.

## Conclusions

Many communities are struggling to define stormwater SCM maintenance needs in the absence of clear documentation. As a step toward providing this information, maintenance activities and costs for a range of stormwater management strategies were calculated. Marginal costs, maintenance frequency, level of effort required, complexity, and pollutant load reductions were all factors that were considered. Annualized maintenance costs were lower for vegetated filter systems (bioretention and subsurface gravel wetland) and porous asphalt pavement and higher for wet and dry ponds. SCMs are increasingly selected for their water quality treatment potential. When TSS load reductions were considered, marginal maintenance costs per mass of pollutant removed were higher for conventional systems and lower for LID systems, with vegetated swales and sand filters as the exceptions. When nutrients such as nitrogen and phosphorus were considered, marginal maintenance costs per mass removed ranged from reasonable to cost-prohibitive, especially for systems with no nutrient removal.

Examination of annual maintenance expenses as a function of capital construction costs indicates that annual maintenance costs for LID systems are not greater than conventional pond systems and, in many instances, have lower annual maintenance costs.

The results of this study indicate that generally, LID systems, compared to conventional pond systems, do not have greater annual maintenance costs and, in most cases, have lower marginal maintenance burdens (as measured by cost and personnel hours) and higher water quality treatment capabilities as a function of pollutant removal performance. Although LID system maintenance will be different and may require additional training, it should not require unusual burdens for management. While maintenance expenses have been presented in this paper as a unit cost per year per area of impervious cover treated, it is not clear that operation and maintenance costs are scalable. Research on scalability, costs with respect to temporal variations, and costs associated with different land uses and location (urban vs. rural) will all play a factor in overall maintenance burden calculations and should be a focus of future research.

## Acknowledgments

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## **A6. EPA GUIDE FOR VOLUNTARY LONG-TERM PLANNING**



# COMMUNITY SOLUTIONS FOR STORMWATER MANAGEMENT

A Guide for Voluntary Long-Term Planning



 **EPA** United States  
Environmental Protection  
Agency


Office of Water  
October 2016

[www.epa.gov/npdes/stormwater-planning](http://www.epa.gov/npdes/stormwater-planning)

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## DRAFT

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The purpose of this guide is to assist EPA, states and local governments in developing new or improving existing long-term stormwater plans that inform stormwater management implemented by communities on the ground. The document describes how to develop a comprehensive long-term community stormwater plan that integrates stormwater management with communities' broader plans for economic development, infrastructure investment and environmental compliance. Through this approach, communities can prioritize actions related to stormwater management as part of capital improvement plans, integrated plans, master plans or other planning efforts. Early and effective stormwater planning and management by communities as they develop will provide significant long-term cost savings while supporting resilience, economic growth and quality of life.

EPA considers this guide a draft that will be supplemented with an integrated online tool to assist communities in implementing the planning process, piloted through community-based technical assistance efforts, and updated over time with feedback from users.



Photography courtesy of Alisha Goldstein

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# I. INTRODUCTION

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Stormwater management is a major and growing challenge nationwide, with stormwater pollution, flooding and other impacts imposing serious impacts on water quality, public health and local economies. EPA recognizes the technical and financial challenges that communities face in appropriately addressing stormwater pollution. At the same time, managing stormwater over the long term can create opportunities for communities to rediscover rainwater as a resource, invest in resilient infrastructure, revitalize urban waterways and introduce green space that makes communities more livable. The agency is introducing this voluntary guide to lay out a path forward that any community<sup>1</sup> can use to facilitate cost-effective, sustainable and holistic solutions that protect human health and manage stormwater as a resource. This guide offers a comprehensive approach for communities looking to achieve multiple community goals simultaneously. The agency understands that effectively managing stormwater will require long-term investments. This guide provides EPA's support for comprehensive stormwater planning for investments spanning many years. Communities using this long-term approach have the potential to identify new and broader financial resources and to get out in front of future regulatory commitments through forward-looking planning and investments. Planning and investing in this way can help to proactively address the costly and difficult water pollution problem and public health concern that urban stormwater continues to pose.

In the face of climate change, it is increasingly important that communities reevaluate how best to make use of their water resources and treat rain and stormwater as the resource they are. Communities can no longer afford to allow stormwater laden with trash, metals and pollutants to contaminate local waters. A new generation of management practices has emerged to effectively manage stormwater while simultaneously building vibrant, attractive communities. Green infrastructure (e.g., green roofs, permeable pavement, bioswales, rainwater harvesting, green streets, stormwater parks, conservation areas) can effectively address stormwater pollution and mitigate flooding, while at the same time providing open space for recreation, habitat, improved air quality, climate resiliency and aesthetic benefits. When used in conjunction with gray infrastructure, these approaches, can create an effective stormwater infrastructure network. These innovative practices also help to revitalize community economies, particularly for communities in need, by supporting sustainable local jobs, improving community assets and reducing blight.

As communities grow and develop their local economies, they're looking for sustainable and effective approaches to reduce existing and emerging sources of stormwater pollution while balancing other community priorities. Sound investments in systems to manage stormwater can complement community development initiatives and promote economic vitality.

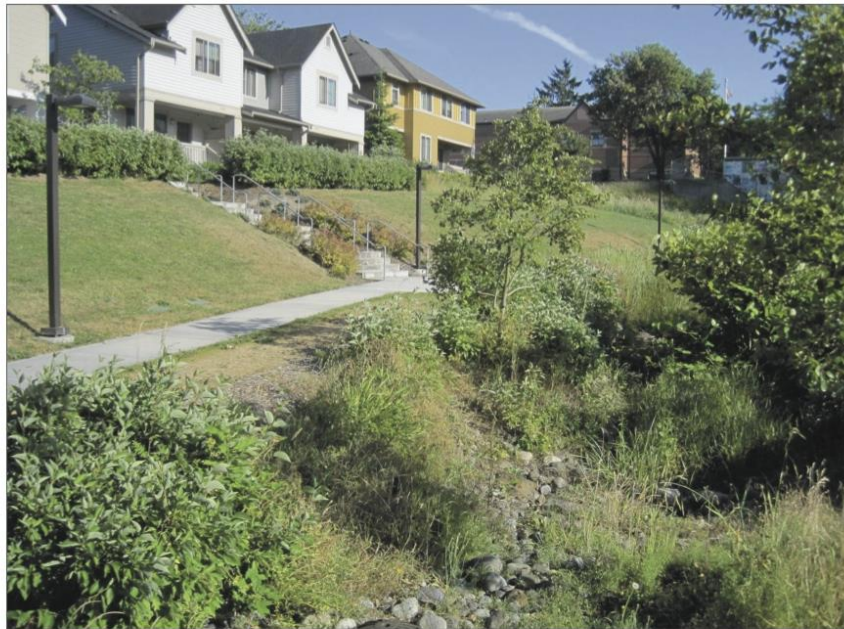
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<sup>1</sup> A community can include entities like cities, towns, townships, boroughs, transportation departments, universities and counties.



Many communities are rediscovering that stormwater is a valuable freshwater resource to combat drought conditions, while others are using green infrastructure to reduce localized flooding events. Cities and towns across the nation are evaluating and adopting integrated approaches to managing stormwater in order to reduce water and wastewater treatment costs, provide adequate water supplies and protect local waterbodies.

Across the country, forward-thinking communities are proving that revitalized water resources and smart green infrastructure solutions can be central drivers of economic development, community vitality and resiliency. Every community is different, but all share the ultimate goal of having clean water that is safe for people to use and enjoy. Developing a long-term plan for stormwater management can help communities find new opportunities for improvements and address these challenges. While identifying planning and management approaches that are economically and environmentally effective is a significant hurdle for many communities, well thought-out plans can help to guide smart policies and investments. These plans also can help open the door to potential new sources of funding by strategically identifying long-term community goals and better aligning activities with a comprehensive water resource management focus.



## II. CONCEPTS GUIDING SMART INFRASTRUCTURE INVESTMENTS

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EPA recognizes that each community has a set of unique circumstances that influence the planning process and the community's ability to finance and implement appropriate solutions for long-term stormwater management. Differences in regulatory status, governance, financial status, community size, geography and technical and programmatic expertise require a process that can be tailored to the needs of individual communities.

Any community may develop a long-term stormwater plan. Because of the multiple benefits of long-term stormwater plans, especially the resiliency-focused benefits of reduced flooding and augmentation of local water supplies, communities with unregulated MS4s may want to consider developing these plans to make proactive infrastructure decisions.

The approaches in this guide are built on a foundation of input from sustained engagement with key partners including states, communities, business/industry groups, academia and nongovernmental organizations. This foundation, comprised of the following concepts, undergirds the overall process:

- 1 By adopting a long-term approach to planning, communities can provide for plan implementation that allows for the integration of selected projects within other community development plans such as capital improvement plans and master plans.
- 2 Managing stormwater close to where precipitation falls, such as with retention or a similar hydrologically focused approach, has been shown to be an effective stormwater control method.
- 3 Innovative technologies, including green infrastructure, are important tools that can generate many benefits ranging from improved air and water quality to cost savings to more community amenities. They also may be fundamental aspects of communities' plans for integrated solutions.
- 4 The voluntary approach to long-term planning described in this guide can be a useful part of the larger effort to comply with any Clean Water Act (CWA) requirements (e.g., over multiple permit cycles). For example, a regulated municipal separate storm sewer system (MS4) that has developed an initial plan may work with EPA and/or the state to consider how the plan can help satisfy the requirements of their permits.<sup>2,3</sup>

<sup>2</sup> EPA recognizes that states, as our partners in the implementation of the CWA stormwater management programs, have the lead for the day-to-day activities in approved NPDES states.

<sup>3</sup> EPA understands that communities need sufficient time to implement flexible, community-integrated approaches within effective and comprehensive long-term stormwater plans.

### III. COMPONENTS OF A LONG-TERM STORMWATER PLAN

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This section sets forth the key steps in the development of a long-term plan, including elements to include in the plan and related questions to explore for laying the groundwork of the planning process.

For those communities that are regulated under the NPDES program, stormwater discharge requirements for regulated MS4s are included in permits that are effective for a maximum of five years. Regulated communities should consider how long-term stormwater planning can assist them in meeting specific permit requirements.

Long-term stormwater plans may address source water protection efforts and reduce nonpoint source pollutants through proposed trading approaches or other mechanisms. These plans may also address stormwater contributions causing localized flooding and sewer overflows.

When developing the plan, a community should determine and define the scope of the integration effort, ensure the active participation of entities that are needed to implement the plan, and identify the role each entity will have in implementing the plan.



Long-term stormwater planning does not remove obligations to comply with the CWA, nor does it change existing regulatory or permitting standards or requirements. Rather this approach recognizes the flexibilities in the CWA for the appropriate sequencing and scheduling of work to meet the requirements of the Act and implementing regulations.





## STEP 1 - ASSESS WHERE YOU ARE NOW

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### ELEMENT 1

Identify the goals of the long-term stormwater planning effort, incorporating existing community objectives, such as the following:

- ☐ Stormwater runoff volume reduction, increasing infiltration, groundwater recharge and rainwater harvesting.
- ☐ Water quality.
- ☐ Capital improvements (including transportation, complete streets and public schools).
- ☐ Flooding reduction.
- ☐ Resiliency.
- ☐ Economic development to attract resources to the community.
- ☐ Social amenities for health or wellbeing of the community (including parks, urban gardens, green space, public art space, bike lanes and other transportation).
- ☐ Open space preservation.
- ☐ Natural channel, watershed, shoreline and/or natural floodplain functions protection.



## STEP 1 - ASSESS WHERE YOU ARE NOW

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### ELEMENT 2

Describe any applicable water quality and human health issues to be addressed in the plan, including the following:

- ☐ Identification and characterization of the chemical, physical and biological quality of the waterbodies, including unimpaired waters, impaired waters, water quality threats and, where available, applicable wasteload allocations (WLAs) of an approved total maximum daily load (TMDL) or an equivalent analysis.
- ☐ An assessment of existing and long-term stormwater management challenges in meeting CWA requirements and projected future CWA requirements (e.g., water quality-based requirements based on a new TMDL).
- ☐ Identification and characterization of human health risks.
- ☐ Identification of sensitive areas and environmental justice concerns.
- ☐ Linkages to goals in local planning documents.

#### GROUNDWORK QUESTIONS

Are there applicable state requirements and planning efforts and can they incorporate state input on priority setting and other key implementation issues?

For regulated MS4s, what are water quality standards and other provisions of the CWA including existing flexibilities in the CWA and its implementing regulations, policies and guidance to consider?

How is the plan consistent with, and designed to meet the objectives of, any applicable total maximum daily loads (TMDLs)?





## STEP 1 - ASSESS WHERE YOU ARE NOW

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### ELEMENT 3

Describe existing stormwater systems and their performance, including the following:

- ☐ Identification of communities and utilities that are participating in the planning effort and a characterization of their systems.
- ☐ Characterization of flows into and from the systems.
- ☐ Consideration of how current system performance may be impacted by changes in local climate (e.g., changes in precipitation and temperature).
- ☐ Assessment of new development, redevelopment and areas without adequate stormwater management that could use improvement.



## STEP 2 - ANALYZE OPPORTUNITIES

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### ELEMENT 4

Institute and document how open communication with relevant stakeholders will be maintained in order to facilitate full consideration of all viewpoints in the planning and implementation of the plan. This process can be part of other on-going public involvement efforts that consider the following:

- ☐ Identify target audience groups and potential partners like watershed, industry, development and community groups (particularly those related to identified goals).
- ☐ Create opportunities for meaningful input during the identification, evaluation and selection of alternatives and other appropriate aspects of plan development.
- ☐ Make new information available to the public and any proposed modifications to the plan.
- ☐ Evaluate the implementation of the approach for communities with green infrastructure requirements in their permits or an enforcement order.

#### GROUNDWORK QUESTIONS

What are the community impacts and will there be disproportionate burdens resulting from current approaches as well as proposed options?



## STEP 2 - ANALYZE OPPORTUNITIES

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### ELEMENT 5

Identify, evaluate and select stormwater management alternatives based on identified goals and objectives that address the following:

- ☐ Sustainable infrastructure planning approaches, such as asset management, to assist in tracking the necessary information for prioritizing investments in and renewal of major stormwater systems.
- ☐ A systematic process to consider green infrastructure and other innovative measures where they provide more sustainable solutions.
- ☐ Criteria to be used for comparing alternative projects, including those related to sustainability, and a process used for comparing alternatives and selecting priorities.
- ☐ Potential and planned non-structural and structural investments.
- ☐ Rate and document all options including: cost estimates, potential disproportionate burdens on portions of the community, projected pollutant reductions, benefits of receiving waters and other environmental and public health benefits associated with each option.
- ☐ A description of the relative priorities and optimization of the projects selected including a description of how the proposed priorities address adverse impacts on public health and water quality.

#### GROUNDWORK QUESTIONS

Where can effective watershed approaches and sustainable technologies, particularly green infrastructure be incorporated for stormwater control, resiliency and hazard mitigation?

Are there approaches to control stormwater in the long term from new development and redevelopment in the early planning phases and after construction ends to minimize stormwater runoff and potential sources of stormwater pollution?

Can existing stormwater discharges from already developed areas be reduced through retrofits and/or redevelopment on public and/or private land?

What projects are part of planned public works investments? Can they catalyze retrofits, promote comprehensive community-focused outcomes that address human health and water quality, and capitalize on cost efficiencies?



## STEP 3 - MOVE TOWARD IMPLEMENTATION

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### ELEMENT 6

Document a process for proposing investments and implementation schedules. Include consideration of the following:

- ☐ Stakeholder groups – other communities, local groups, states, federal agencies, planning organizations and universities – in order to coordinate resources and actions.
- ☐ Life-cycle costs, including capital and operation and maintenance investments that help implement the plan.
- ☐ Proposed implementation schedules and, if applicable, alignment of implementation schedules with other existing efforts.
- ☐ A financial strategy for each entity participating in the plan to ensure investments are sufficiently funded, operated, maintained and replaced over time.

#### GROUNDWORK QUESTIONS

How do we provide appropriate opportunity for meaningful stakeholder input when proposing investments and implementation schedules?

Is there a financial strategy in place, including appropriate fee structures, to support capital investments and long-term operations and maintenance?

10



## STEP 3 - MOVE TOWARD IMPLEMENTATION

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### ELEMENT 7

Document a process for evaluating the performance/success of the plan's projects. Evaluate projects as they are being implemented, which may involve evaluation of monitoring data, information developed by pilot studies and other studies and other relevant information, including the following:

- ☐ Propose performance metrics: Track metrics using modeling and monitoring results and costs to measure the success of human health and water quality objectives and the effectiveness of controls.
- ☐ Evaluate the performance of site-specific and large-scale green infrastructure and other innovative measures to inform adaptive design and management. Include identification of barriers to full implementation.
- ☐ Track cost savings gained due to long-term planning efforts.



## IV. THE PLAN IS FINISHED - WHAT'S NEXT?

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### BUILD IT

Identify, evaluate and select new projects or modifications to ongoing or planned projects and implementation schedules:

- In situations where a community is seeking modification to a plan, or to the permit that is requiring implementation of the plan, the community should collect the appropriate information to support the modification and should be consistent with Elements 1 – 7 discussed above.
- This long-term stormwater planning approach can also inform the recently embraced integrated planning approach to municipal wastewater and stormwater management. Integrated planning encourages communities to take a comprehensive planning approach to clean water management by making strategic, long-term investments in their wastewater and stormwater systems.
- These planning approaches will assist communities on their critical paths to achieving the human health and water quality objectives of the CWA by identifying efficiencies in implementing requirements that arise from distinct wastewater and stormwater programs, including how best to make capital investments.

### INCORPORATE IT INTO AN NPDES PERMIT

All or part of a long-term stormwater plan can inform an NPDES permit as appropriate. Permit writers can use the proposed implementation schedules included in the plan to develop clear, specific and measurable permit requirements that are consistent with applicable regulations. Identifying milestones of a long-term stormwater plan in NPDES permits can support the community's goals while simultaneously providing regulatory predictability.

Limitations and considerations for incorporating long-term stormwater plans into permits include:

- Specific activities to be implemented during the permit term.
- Measurable goals and metrics for tracking progress with the plan.
- Reopener provisions in permits consistent with section 122.62(a) may better facilitate adaptive management approaches.
- Securing funding.
- Green infrastructure approaches at site-specific and larger scales and related innovative practices that provide more sustainable solutions by managing stormwater as a resource should be considered and incorporated, where appropriate, where they provide more sustainable solutions for municipal wet weather control.
- Appropriate water quality trading may be reflected in NPDES permits.
- Annual reporting requirements.

12

## **COMMUNICATE IT**

Communities may want to coordinate with their state and federal partners when getting ready to implement their long-term approaches. For example, some of these other partners may be able to help a community determine if it's eligible for certain funding to complete projects or parts of projects.

EPA recognizes the importance of and encourages early coordination between NPDES states and EPA on key implementation issues that may arise in individual plans. This will ensure that plans will not need to be revised in order for them to be implemented.

## **REFINE IT**

Establish a process for periodically reviewing the plan to consider the results of performance metrics. Continue to identify opportunities to integrate with new community goals, public works projects and integrated planning efforts.

## V. CONCLUSION

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EPA considers this guide a draft and encourages feedback. EPA will also provide an online toolkit to assist communities in implementing the planning process, piloted through community-based technical assistance efforts, and updated over time with feedback from users. For additional information go to: [www.epa.gov/npdes/stormwater-planning](http://www.epa.gov/npdes/stormwater-planning)

Long-term stormwater plans can support community efforts to prioritize and implement effective stormwater management practices. Integrating these plans with broader community goals such as economic development, infrastructure investment and environmental compliance leverages the planning effort to support resilience, economic growth and quality of life.

With this guide, any community can lay out a path forward to cost-effective, sustainable and comprehensive solutions that protect human health and manage stormwater as a resource.





## **A7. TOWN OF MILTON 2014 ANNUAL MS4 PERMIT REPORT**

**Town of Milton  
MS4 Annual Report  
2014**

In accordance with General Permit 3-9014 the Town of Milton has continued to implement a stormwater management plan amended and approved in 2008. The original stormwater management plan was approved in 2004. In anticipation of revised rules in response to new TMDL & Stormwater legislation, the Town is beginning to review and revise its Public Works Specifications and stormwater related practices.

The following is a summary of the progress made toward achieving the statutory goal of reducing the discharges of stormwater pollutants to the maximum extent practicable. The report is formatted based on the original Stormwater Management Plan. Progress towards each measurable goal is written in *italic* with attachments noted.

**Table 1  
Public Education and Outreach  
Implementation Schedule and Goals**

<b>Best Management Practice</b>	<b>Schedule</b>	<b>Measurable Goal</b>	<b>Responsible Party</b>
Actively participate in the RSEP	2014	As outlined in the RSEP MOU	Town Engineer/Town Planner
<i>The Town of Milton has actively participated in the RSEP and paid yearly dues of \$5,000. A yearly summary of the RSEP program accomplishments is in Attachment 1.</i>			
Disseminate information using the Town website	2014	Maintain website and document the number of contacts and feedback received on website.	Administrative Assistant/Town Engineer
<i>The Milton Town Stormwater Web Page, <a href="http://miltonvt.org/departments/publicworks/pwadmin/stormwater.html">http://miltonvt.org/departments/publicworks/pwadmin/stormwater.html</a> received 14 visits. The CCST reported 25 website hits from Milton to the CCST website for 2014</i>			
Site Plan and Subdivision Review	2014	Actively disseminate stormwater information during building permit and site plan review.	Planning Department
<i>Town staff provides stormwater educational material to the public and developers at the Planning Office and Public Works Office.</i>			
<i>The development review technical advisory committee reviewed approximately 12 site plan and subdivision applications during CY 2014. Staff consistently commented on erosion and stormwater control best management practices and State permit requirements. See attachment 1 - Planning and Economic Development FY 2014 Annual Report.</i>			

**Table 2**  
**Public Involvement Participation**  
**Implementation Schedule and Goals**

<b>Best Management Practice</b>	<b>Schedule</b>	<b>Measurable Goal</b>	<b>Responsible Party</b>
Citizen Stormwater Advisory Panel	2014	Discuss stormwater issues related to the Town with the Selectboard as necessary	Town Manager
<i>The Selectboard re-certified compliance with January 2013 Town Highway and Bridge Standards (as amended), which improve design and maintenance standards of gravel roads and bridges in order to better protect our waterways from stormwater degradation.</i>			
Maintain and Improve the Lamolile River Walk.	2014	Undertake stream corridor cleanup on Green-Up Day. Quantify volume of waste collected.	Conservation Committee & Volunteers
<i>No maintenance was done by the Conservation Committee on this trail, but this is a 2015/16 priority.</i>			
Sponsorship of Stream Corridor Cleanup	2014	Undertake stream corridor cleanup on Green-Up Day. Quantify volume of waste collected.	Green-Up Day Committee Volunteers
<i>Green-Up Day 2014. Less than 1 cubic yard of metal was collected by volunteers in Milton. They also collected 2.25 tons of trash and 300 tires. There was a good community turnout with over 200 volunteers and the day was a success.</i>			
Actively participate in the Regional Stormwater Public Involvement and Participation Program	2014	As outlined in the Stream Team Work Plan	Town Engineer/Town Planner
<i>The Town continues to support the Regional Stormwater Public Involvement and Participation Program and the Stream Team Work Plan. The Town's Stormwater Management Plan was in 2013 and the new MS4 inclusion was issued in October 2013. The SWMP was submitted with the new permit NOI in June of 2013. The results of the Chittenden County Stream Team (CST) efforts are included as attachment 2.</i>			

**Table 3**  
**Illicit Discharge Detection and Elimination**  
**Implementation Schedule and Goals**

<b>Best Management Practice</b>	<b>Schedule</b>	<b>Measurable Goal</b>	<b>Responsible Party</b>
Stormwater System Map	2014	Update stormwater system map as necessary	Town Engineer
<i>No new stormwater infrastructure was accepted by the Town of Milton within the MS4 permitted area in 2014. System and Infrastructure maps and data are updated using GIS and more recently the Vermont Online Bridge and Culvert Inventory Tool. The Town will be coordinating with the CCRPC this year to update our culvert and bridge inventory. The updates will be recorded using the Vermont Online Bridge and Culvert Inventory Tool.</i>			
Ordinances	2014	Enforce Dog Ordinance and Stormwater Ordinance.	Town Engineer/Police Dept./Health Officer
<i>No ordinance complaint/requests related to stormwater were reported.</i>			
Program to Detect and Eliminate Illicit Discharges	2014	Continue program of dry weather monitoring of stormwater outfalls as described in the IDDE program along with mitigation of illicit discharges as necessary.	Town Engineer/ Highway Superintendent
<i>There were no reported illicit discharges in 2014. However, one major slope failure was repaired on Beebe Hill Road which could have caused significant sedimentation deposits in Stone Bridge Brook. A minor slope failure was repaired at a drainage gully near Stacy Street, left unchecked this slope failure had the potential to negatively impact a tributary of the Lamoille River.</i>			
Public Education Regarding Illicit Discharges	2014	Attend municipal employee training workshop; public education and involvement as described in sections 4.2.1 and 4.2.2; school personnel attend stormwater training	Public Works Employees/ See Section 4.2.1, 4.2.2
<i>All employees from the Highway and Buildings &amp; Grounds Divisions attended the municipal employee Stormwater workshop in 2014. Additional trainings and seminars were attended by Public Works staff members.</i>			

**Table 4**  
**Construction Site Stormwater Runoff Control**  
**Implementation Schedule and Goals**

<b>Best Management Practice</b>	<b>Schedule</b>	<b>Measurable Goal</b>	<b>Responsible Party</b>
Site Plan and Subdivision Review	2014	Conduct plan review for compliance with Erosion Control Specification for land disturbances.	Town Engineer/ Planning Department
<i>The development review technical advisory committee reviewed 12 site plan and subdivision applications during 2014. Staff consistently commented on erosion and stormwater control best management practices and State permit requirements.</i>			
Inspection and Enforcement	2014	Inspect all locally permitted projects for compliance with the Erosion Control Specification. Take appropriate action for noncompliance. Develop a program to assist the State with inspection of State permit conditions.	Town Engineer/ Zoning Administrator
<i>The Town is aware of 2 projects that were active in 2014 and were over one acre in disturbance. Staff routinely inspected the sites and commented on the use of Stormwater BMP's.</i>			
<i>Approximately 12 erosion control visits were completed by the Town during the 2014 construction season on both Town projects and private development projects.</i>			
Properly permit Town Construction activities	2014	Obtain and comply with State permits	Town Engineer/ Project Managers
<i>No projects requiring State permits were active in 2014.</i>			



**Table 5**  
**Pollution Prevention/Good Housekeeping for Municipal Operations**  
**Implementation Schedule and Goals**

<b>Best Management Practice</b>	<b>Schedule</b>	<b>Measurable Goal</b>	<b>Responsible Party</b>
WW Act 154 Plan	2014	Acceptance of Operation, Maintenance and Emergency Response Plan	Wastewater Superintendent
Approximately 13,000 LF of wastewater sewer and manholes were cleaned in accordance with the approved Wastewater System Operation, Management, and Emergency Response Plan (also known as a sewage spill prevention plan). In addition, 21 Manholes were sealed, raised or reconstructed.			
Operation and Maintenance Program	2014	Maintain operation and maintenance programs as identified	Public Works Dept.
The Town continues annual maintenance programs in the public ROW including, ditching, street sweeping, catch basin and storm sewer cleaning, culvert replacement and roadside mowing.			
<p>In 2014 the Public Works Department continued its focused on issues related to maintenance and cleaning existing stormwater structures and drainage systems:</p> <ul style="list-style-type: none"> <li>Cleaned ditches and cut shoulders throughout the former village area, and along Beebe Hill Rd and Cadreact Rd. Approximately 44,000 linear feet of roadside were cleaned, and seed and mulch were applied for stabilization.</li> <li>Cleaned pipes and catch basins primarily around the Herrick Ave and school area.</li> <li>Cleaned sediment and debris from several other culverts as a result of storm related activities.</li> <li>We replaced only a few culverts over the course of the construction season, 30' of 15", 240' of 18", and 60' of 24".</li> <li>Street sweeping collected roughly 16 yards of material from our roadways, and we also continued with sweeping of our sidewalk network.</li> <li>Reviewed stormwater outfalls and made repairs as needed.</li> </ul>			
Multi-sector General Industrial Stormwater Permit	2014	Comply with permit requirements	Town Engineer
The Town has "No Exposure Certification" for conditional exclusion from the Multi-Sector General Permit for the WWTF and the Milton landfill (closed).			
Municipal Compliance Assistance Program	2014	Continue to follow and improve upon recommendations from the MCAP	Public Works Dept.
The Town Highway Department continues to improve on its highway garage operation and maintenance such as cleaning silt from yard basin at the Highway Garage and adding new stone level spreaders to the basin and at the edge of the parking lot. This is unchanged from previous years and is an ongoing improvement process.			